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Managing uncertainty in innovative projects: The experimentation-driven approach

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Abstract

Uncertainty is an essential characteristic of the future, and in novel contexts such as innovation or the creation of new business ventures there is usually little or no precedent or experience to make accurate forecasts of the results. This creates a need for non-predictive approaches that can be used to proactively manage uncertainty. The experimentation-driven approach to innovation is presented as one such method, and this thesis examines how its use affected uncertainties in two innovative projects.

A combination of case study and action research methods was used in an interventionist fashion, where two teams from a client organisation were tasked to create and develop new ideas. We instructed them on using the experimentation-driven approach and arranged weekly coaching sessions until the projects were over.

To study the changes in uncertainty, an interpretive approach was used with thematic analysis as a method for analysing the data, which consisted mainly of semi-structured interviews of each team member, as well as video recordings captured during the weekly coaching sessions.

The analysis of the two experimentation-driven projects demonstrates how uncertainty can be a concern even in seemingly simple and small attempts at creating something new. Furthermore, the findings of this research show that experimentation can be used to quickly learn about those uncertainties, and also to uncover unforeseen items that may have significant importance for the original ideas and concepts.

This thesis was done as part of the two-year MINDexpe research project, undertaken by the MIND research group of Aalto University and funded by Tekes.

Keywords experimentation, innovation, project management, uncertainty

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All the rest of my colleagues in the MIND research group for inspiration, excitement, fascinating discussions, and the drive to change the world for the better.

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1 INTRODUCTION

You are an aspiring entrepreneur, eager to start your own business. You have two different ideas, both of them full of potential. Which one should you pursue?

You are a product manager in a large manufacturing company. A senior engineer presents you with an idea that may potentially expand the use of your products to entirely new customer segments, but it may also alienate your existing customers. Should you implement the idea?

You are responsible for developing quality assurance processes in a financial services company. According to reports from customers, the perceived quality of your company's services is inferior to your largest competitor. As a result of an internal competition for ideas to improve the quality you now have 76 proposals on your desk. Some are easy to discard based on your experience and their mismatch with the company strategy, but that still leaves you with 44 proposals. Which ones should you assign people and resources to for further development?

1.1 BACKGROUND

All the examples above, and many more imaginable, illustrate how uncertainty is present in business decisions. There have been attempts to decipher the building blocks of successful businesses. For example, *Built to Last* (Collins & Porras, 1994) and its sequel *Good to Great* (Collins, 2001) were supposed to be based on best research available, giving the formula for creating a business that thrives and stands the test of time. Yet all of those supposedly exemplary companies modelled in the books have not fared so well; Circuit City has since gone bankrupt, Fannie Mae was taken over by the US government in the aftermath of the 2008 financial crisis, and Wells Fargo had to

take a $25 billion loan. Similarly, one third of the companies presented in *In Search of Excellence* (Peters & Waterman, 1982) had failed to meet the criteria for superiority as set by the authors merely two years after the books publication (Kiechel, 2012).

This is not to say that the formulas, principles, and methods presented in business books are outright falsehoods, but they are products of the world and thinking as it was at the time they were written. The problem is that the world moves on — sometimes at a blistering speed. Biggadike (1979) and Quinn (1979) wrote less than four decades ago that it takes an average of 10-12 years for a ROI in a startup to equal that of a mature business, and 7-15 years for an invention to reach financial success (Kanter, 1985). This is in stark contrast to the rapid rises and falls seen during the Internet age: Facebook was taken from an idea to IPO in eight years. Google was founded in 1998 and went public in 2004. YouTube was founded in 2005 and had its exit as soon as in 2006 when Google paid $1.65 billion for it in stock. And most recently in October 2013 the Finnish Supercell, established in the summer of 2010 with five employees and $12 million in seed capital, sold its majority stake for $1.53 billion with a valuation of over $3 billion.[1]

On the flip side of the coin, the video rental chain Blockbuster was driven bankrupt by online services such as Netflix, Hulu, and Apple's iTunes store. The smartphone map and navigation applications saw the GPS device maker Garmin lose 70% of its market capitalisation, while TomTom lost nearly 85% in the course of just two years. And smartphones were not even meant to compete with the GPS devices in the first place. (Downes & Nunes, 2013.)

The pace of change in the current environment is unprecedented and so is its complexity (e.g. Anderson, 1999; Arthur, 1999; Williams, 1999; Pich, Loch, & De Meyer, 2002). Thanks to social media sites such as Twitter, tidbits of information will reach a global audience in minutes, and consequently very small things can result in a very large impact at the speed and scale that has never been experienced before in human history. A single case of bad customer experience may be shared thousands of

[1] The figures in this chapter are based on publicly available information on the company websites and various news media sources.

times, leading to a disproportional net negative effect. In this kind of environment it is increasingly important to be able to move fast, while at the same time it becomes more and more difficult to predict all the possible consequences of one's actions (Hamel, 1996; Brown & Eisenhardt, 1998).

A part of the reason why this situation is so problematic might be that our thinking, especially in the Western world, has been shaped to accommodate the Newtonian worldview of linear and clear cause-and-effect relationships. Study hard and you get better grades. Work harder and you will be promoted. The bigger the input, the greater the output, and so forth. For example, the principles of Scientific Management, production line, organisational structures, and business plans are all echoes of the Newtonian worldview. We have come to believe in our ability to dismantle a complex system into pieces, optimise each piece in isolation, and accurately predict the outcome when the pieces are put back together into a whole system. (Wheatley, 2006; Cooke-Davies, Cicmil, Crawford, & Richardson, 2007.)

However, projects, organisations, industries, and whole business environments are not mechanistic systems, and therefore cannot be understood properly by methods that are rooted in Newtonian thinking. Instead, they should be seen as complex dynamic systems. (Gell-Mann, 1994; Anderson, 1999; Carroll & Burton, 2000.) They exhibit nonlinear behaviour that only exists in the system as a whole, and cannot be seen by studying its constituent parts in isolation. Taking into account that the behaviour of these systems can change dynamically poses serious problems when it comes to attempts to predict the future. (Casti, 1994; Simon, 1996; Sommer & Loch, 2010.) What may work well in mechanistic and established environments — e.g. when building ships or bridges, or introducing incremental product updates — is likely to be ill-suited for truly novel or emerging contexts, such as the Internet of Things (Atzori, Iera, & Morabito, 2010), making pricing decisions when there is no established market for the product or service, hiring people for an organisation that is not yet established, or valuing firms in a nascent industry (Sarasvathy, 2001).

In a marketplace that is constantly changing it is practically impossible to know beforehand which innovations will become successes, and it is not necessarily always the most economically efficient solutions that win (Arthur, 1989; Alvarez & Barney, 2007; Dew, Sarasvathy, Read, & Wiltbank, 2009). This presents a challenge also to strategic management, which is fundamentally concerned with how firms can achieve and sustain competitive advantage (Teece, Pisano, & Shuen, 1997). Simply put, such a thing does not exist in an environment that is continuously being created and shaped by the numerous systems interacting with each other.

The Newtonian worldview reduces uncertainty into a knowable and quantifiable factor. It posits that uncertainty can be analysed, evaluated, and as a result of this process, one can make the most rational decision available. In other words, it does little to account for the existence of events that, by definition, are truly unpredictable (Taleb, 2007). If uncertainty could be reduced to a mere statistical variable, large organisations would not fail (or at least they would do it more gracefully), the failure rate of startups would not be so high, and venture capital investments would be a much more accurate predictor of startup success. After all, who would invest in a venture that is obviously going to fail?

Whether we talk about a startup trying to create a new product or service, or a Fortune 500 company developing new offerings, processes, or going through strategic renewal, uncertainty is present. It will be shown that the traditional ways of managing projects are not just ill-suited to dealing with the downsides of uncertainty, but also have difficulty to take advantage of possible positive surprises. As stated by Kanter (1985, p. 49): “The innovation process involves little or no precedent or experience to use to make forecasts about results. Hoped-for timetables may prove unrealistic, and schedules may not match the true pace of progress.” When adding together the complexity and pace of change present in the modern business environment, developing ways to manage or reduce uncertainty is becoming more and more important for businesses and other organisations.

1.2 RESEARCH OBJECTIVES

When it comes to managing uncertainty and complexity in innovative projects, Sommer & Loch (2004) have presented two high-level approaches: selectionism and learning. They continue by demonstrating with mathematical simulations how the learning approach is better suited for most situations. What has not been studied, however, is how uncertainties are actually affected by either selectionism or learning. In other words, Sommer & Loch (2004) show that uncertainties change, but do not explain how the change actually takes place in real life.

This thesis aims to shine some light into that question by using a qualitative approach to demonstrate how the experimentation-driven approach to innovation — which can be categorised as a method for learning — affected uncertainty in two innovative projects. More specifically, this thesis aims to answer:

1. How well can uncertainties be identified at the outset?
2. How can the identified uncertainties change as a result of experiments?
3. How do unforeseeable uncertainties reveal themselves through the process of experimentation?

This thesis was written as a part of the two-year MINDexpe research project, undertaken by the MIND research group,[2] based in Aalto University Design Factory and operating under the Business, Innovation, Technology (BIT) research centre. The MINDexpe project focuses on studying the experimentation-driven approach to innovation in the context of established organisations. The research is funded by the Tekes funding agency for technology and innovation.

The approach of MINDexpe is to study client organisations as they use the experimentation-driven approach themselves, and while doing so move towards

[2] www.mindspace.fi

methods and thinking that differ from the traditional planning-based approaches. The larger aim is to discover how various organisational conditions may affect the experimentation behaviour, and to further our understanding of experimentation-driven innovation itself.

1.3 METHODOLOGY

The research design used for this thesis is a combination of action research and case study methods. It focuses on the work we did with Mandatum Life[3] — a Finnish financial services company. Because experimentation-driven innovation is not a common occurrence in organisations, an intervention was required to study the phenomenon in a real-life setting. In this case, Mandatum Life purposefully wanted to introduce a new way to develop innovations into their organisation, and participating in the MINDexpe research project served the needs of both their organisational goals and our research interests.

The case study aspect is evident in how this thesis focuses on two experimentation-driven innovation projects undertaken in Mandatum Life. These projects were executed by the employees of the client organisation, while the role of the MIND researchers was to coach them to use the experimentation-driven innovation method, and arrange weekly tutoring sessions where the client employees had a chance to present their progress, analyse and reflect on the results, and plan the next steps.

Each of the aforementioned tutoring sessions was recorded on video, which proved useful in providing a detailed account on how the projects evolved over time. Another

[3] www.mandatumlife.fi

main source of data consisted of semi-structured interviews of each participating employee. The interviews were conducted after the projects were completed.

Thematic analysis (Braun & Clarke, 2006) method was used to analyse the data, with the focus on identifying possible uncertainties and unexpected learning outcomes from the two projects, and describing how they were affected by the experimentation-driven approach.

1.4 STRUCTURE OF THE THESIS

This thesis is structured into seven parts. As explained in the introduction, the starting point is the perspective that reality is complex, unpredictable, and consequently cannot be understood well by relying only on the mechanistic worldview inherent in Newtonian thinking. This is a world characterised by uncertainty, and how that uncertainty is affected by the process of experimentation-driven innovation is the main research question of this thesis.

The literature review is divided into two main sections: First, the concept of uncertainty is discussed in detail in chapter two, and the definitions for uncertainty that are used in this thesis are described. Uncertainty is further distinguished from the concept of risk. Chapter three contains the second part of the literature review, focusing on how to manage uncertainty in innovative projects, and how various project management approaches differ in their treatment of uncertainty.

The methodological approach, alongside a detailed description of data collection and analysis processes, is presented in chapter four. This is followed by the results and analysis from the two projects in the next chapter, with detailed descriptions of identified uncertainties and how they changed over the course of the projects.

Chapter six contains discussion and reflection based on the research findings, and the thesis is concluded in chapter seven, with notions regarding the research results, practical implications for managers, and suggestions for future research.

The appendices contain the interviewer's cheat sheet that was used during the semi-structured interviews.

2 UNCERTAINTY AND RISK

Before talking about managing uncertainty we need to understand what is meant by it, and what is its role in the reality of novel and innovative projects. In order to achieve this, uncertainty is described as a function of outcomes and their probabilities, and for the sake of clarity distinguished from the related concept of risk. The main concern for innovative projects is in the types of uncertainty that are unknown at the outset. Without uncertainty there would be no innovation. Yet these unknown uncertainties cannot be effectively managed with the commonly used planning-based project management approaches (Lenfle & Loch, 2010).

2.1 UNCERTAINTY

Uncertainty is a concept that is widely acknowledged in entrepreneurship and innovation literature. Even when its effects or importance are not directly studied, it remains taken as granted and affecting topics such as the entrepreneurial behaviour of individuals (e.g. Bull & Willard, 1993; McMullen & Shepherd, 2006; Blatt, 2009), new venture development (e.g. Sarasvathy, 2001; Miller, 2007; Sarasvathy, Dew, Read, & Wiltbank, 2008), and innovation activities in established companies (e.g. Kanter, 1985; Lee, Edmondson, Thomke, & Worline, 2004; Menzel, Krauss, Ulijn, & Weggeman, 2008; Kesting & Ulhøi, 2010; Da Costa & Brettel, 2011). Articles on strategy-making have also appeared that argue for the uncertainty and unknowability of the future, and provide suggestions on how to best deal with it (e.g. Eisenhardt & Brown, 1998; Wiltbank, Dew, Read, & Sarasvathy, 2006; McGrath, 2010). In their meta-analysis of effectuation and venture performance Read, Song, & Smit (2009, p. 584) named uncertainty as “the essential characteristic of the future.”

But what does uncertainty exactly mean? According to the Merriam-Webster online dictionary it refers to a situation where the outcome is not known with definite accuracy, hence there is uncertainty. In other words, even a slight hint of variations in the outcome will impose a degree of uncertainty into a situation. This, however, would be an overly simplified view, as it ignores the subtleness between the two dimensions that characterise uncertainty: outcome and probability (Langlois & Cosgel, 1993).

2.1.1 The known and its probability

Frank Knight in his classic work *Risk, Uncertainty and Profit* (Knight, 1921) used the term 'risk' for uncertainty with known outcomes and probabilities. An example of this type of uncertainty would be a roll of six-sided dice: There is uncertainty regarding the number that will come up, but all the six possible outcomes are known before the dice is rolled, and so are the probabilities of each outcome. Assuming the dice is not rigged, each of the six numbers have approximately a 17% chance of coming up. This view on uncertainty as something that can be reduced into known probabilities has been adopted by, for example, the expected utility theory in economics (Camerer & Weber, 1992). Similarly, many traditional planning approaches are built on the assumption that all possible outcomes and their probabilities can be identified by diligent analysis and hard work (Wiltbank et al., 2006).

A step towards more elusive uncertainty is a situation where all the possible outcomes are known at the outset, but their probabilities are unknown. In the decision sciences this is described by the term ambiguity and is part of the domain of subjective expected utility theory (Camerer & Weber, 1992). Ambiguity, as described by Frisch & Baron (1988 cited in Camerer & Weber, 1992, p. 330) contains the particular notion of "uncertainty about probability, created by missing information that is relevant and could be known." An example of this kind of situation would be to bet on the colour of a candy drawn from an unopened bag of M&M's: the range of colours, representing

outcomes, is known, but the distribution of colours inside the bag cannot be known until the bag is opened (Chua Chow & Sarin, 2002).

When it comes to probabilities in ambiguous situations, subjective expected utility theory ignores the notion of them being truly unknown by claiming that one can always give subjective estimates for probabilities (Camerer & Weber, 1992), no matter how low the confidence on the accuracy of those estimates might be. Schrader, Riggs, & Smith (1993) take this argument much further, claiming that no such thing as objective probability exists because even seemingly objective cases, such as a coin toss, still require subjective judgment. In other words, the 50/50 probability in a coin toss is based on a subjective assumption that the outcome is purely random, and where one person could make that assumption someone else might assume that the coin is balanced to favour one face more than the other, or could even land on its side, creating a third possible outcome. Then again, if the probabilities are truly unknowable *ex ante*, a subjective estimate will not be of much practical use. Lane & Maxfield (2005) refer to these kinds of situations of known outcomes with subjective probability estimates as consisting of truth uncertainty or semantic uncertainty, with the latter involving considerably more uncertainty regarding the estimation of probabilities.

2.1.2 The unknown and the unknowable

According to Chua Chow & Sarin (2002) and Loch, Solt, & Bailey (2008), situations with known outcomes and unknown probabilities correspond to what Knight (1921) meant with the term ‘uncertainty’. However, there seems to be some debate about whether Knight’s original meaning in *Risk, Uncertainty and Profit* was that the probabilities of known outcomes are unknown, or that the outcomes themselves also resist classification, meaning that they are inherently *unknowable*. The latter point of view has been argued for by Langlois & Cosgel (1993), and adopted at least in the works of Wiltbank et al. (2006) and Sarasvathy (2008), resulting in the use of the term

'Knightian uncertainty.' According to Langlois & Cosgel (1993), in Knight's definition of uncertainty it does not make a difference whether probabilities can be calculated objectively (as in expected utility) or need to be estimated subjectively (as in subjective expected utility). The distinction between risk and uncertainty still comes down to the classification of instances rather than the nature of probabilities assigned to them. Similar notion of future consequences resisting the formation of propositions is held by the term ontological uncertainty (Lane & Maxfield, 2005).

So far we have covered known outcomes with known probabilities, also called Knightian risk (Miller, 2007), known outcomes with unknown probabilities, i.e. ambiguity (Camerer & Weber, 1992), and inherently unknowable outcomes, or Knightian uncertainty (Langlois & Cosgel, 1993). What remains is the situation where outcomes and probabilities are unknown *ex ante*, but can become known as a result of human action. Sommer & Loch (2004) call these unforeseeable uncertainties. For example, judgment, experience, common sense, and intuition can be used to subjectively identify at least some of the unknown outcomes, depending on the situation, and activities such as trial-and-error learning and experimentation may result in more objective evidence supporting the existence of others (Loch, DeMeyer, & Pich, 2006).

2.1.3 Uncertainty as a function of outcomes and probabilities

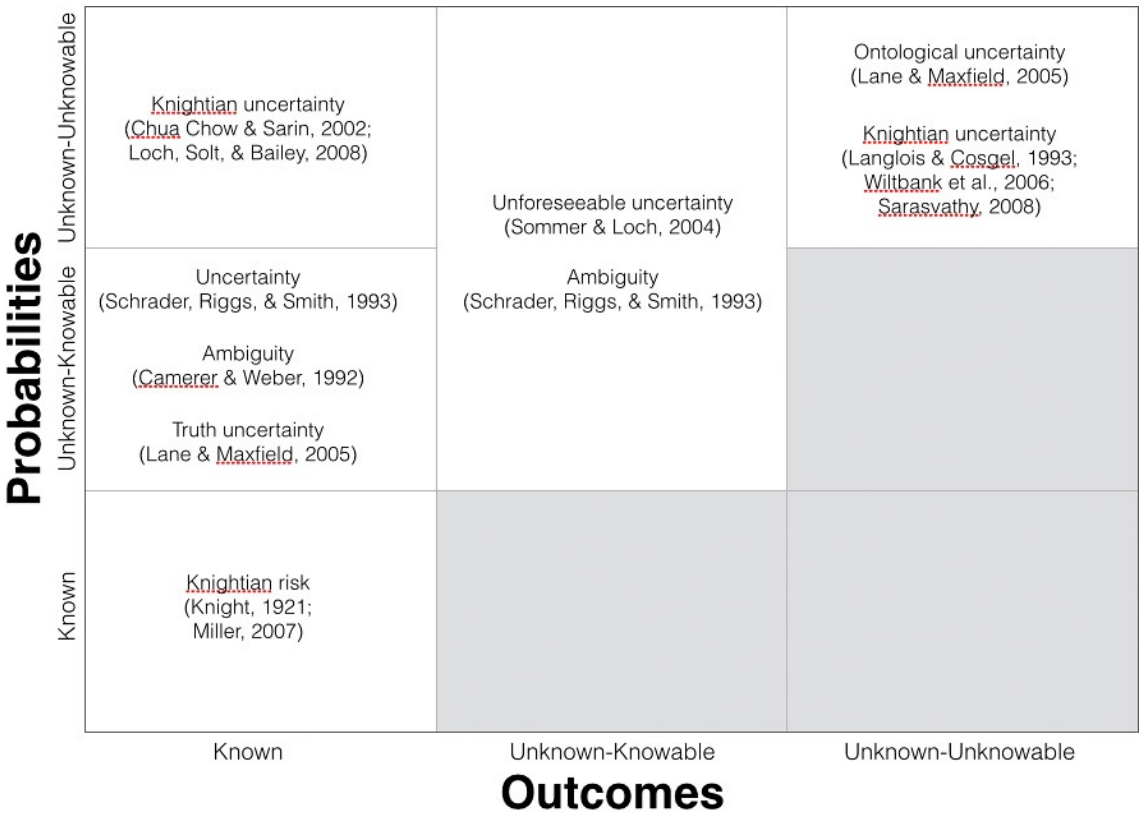
It should be noted that the purpose of this thesis is not to provide a comprehensive review of how the term uncertainty is used in the literature. There are dozens of definitions in use in various contexts, and same terms are used with different definitions depending on the field and the author in question (see Figure 1). For example, Oberkampf, Helton, Joslyn, Wojtkiewicz, & Ferson (2004) provide nine different terms for discussing uncertainty just in the context of computational risk assessment models, and Schrader, Riggs, & Smith (1993) use the term uncertainty to describe what here has

been defined as ambiguity, and ambiguity as what Sommer & Loch (2004) call unforeseeable uncertainty.

For this reason I find it necessary to focus on providing a distinction of different types of uncertainty, as it makes sense and has real-world implications from the point of view of managing innovative projects, although it means selectively ignoring some of the other conceptual definitions of uncertainty. Therefore the following definitions will be used in this thesis:

- *Knightian risk* when the outcomes and their probabilities both are objectively known;
- *Ambiguity* when the outcomes are known but their probabilities are unknown *ex ante*;
- *Unforeseeable uncertainty* when the outcomes are unknown *ex ante;*
- *Knightian uncertainty* when the outcomes are inherently unknowable.

Figure 1: Definitions of uncertainty as a function of outcomes and probabilities.



In the case of both *ambiguity* and *unforeseeable uncertainty* it is reasonable to avoid treating them as absolute states. For example, using the aforementioned definitions, the case of a bag of M&M candies falls under ambiguity: It is ambiguous in a sense that before the bag is opened we cannot know the probability distribution objectively, but nevertheless we can safely give *some* subjective estimates of a range within which the probabilities are, meaning that the probability is not truly unknown either. (Camerer & Weber, 1992.) After all, the bag can only hold so many pieces of candy, and a seasoned M&M eater should be able to confidently estimate the range between which the number of different coloured candies will fall. Similarly with unforeseeable uncertainties we might be able to use our intuition and experience to identify a number of possible outcomes (Loch, DeMeyer & Pich, 2006), but attempts to assign any probabilities to these outcomes would be more prone to erroneous judgments than in the case of ambiguity, unless we can be sure that we have managed to identify all the outcomes there are.

On the other hand, when it comes to Knightian uncertainty, which by definition is unknowable *ex ante*, the classification of alternative outcomes — and consequently the estimation of their probabilities — would most likely be impossible also *ex post.* In other words, in situations characterised by Knightian uncertainty, we can observe what happened, but would be unable to identify all the possible alternative histories that might have happened instead. (Taleb, 2007.)

2.1.4 Uncertainty and innovation

Distinguishing between different types of uncertainty is not only meaningful for understanding uncertainty itself, but also for understanding innovation. It makes logical sense to presume that uncertainty has a limiting role when it comes to the range of potential innovations, from incremental to radical. If the starting point already assumes known outcomes (for example, a reduced throughput time on a production line), the

potential to innovate is inherently lower and more likely to be incremental than if the starting point assumed an unknown future state with a broader solution space (for example, a better way to produce complex electronic components). (Kline & Rosenberg, 1986.) A similar distinction is made by March (1991) in his discussion of exploitation and exploration processes.

Even though the potential to innovate is highest where the outcomes are either unknown-knowable or unknown-unknowable, many innovative projects — even those that contain high degrees of uncertainty — are still managed as if the outcomes were known at the outset (Lenfle & Loch, 2010). Therefore it is worth considering alternative project management methods, such as the experimentation-driven approach, that acknowledge the existence of unforeseeable and Knightian uncertainty, and contain ways to incorporate uncertainties as essential parts of the project.

2.2 RISK

Risk is a term that is often used together with uncertainty, due to which it deserves some treatment of its own. As mentioned earlier, Frank Knight (1921) used the term ‘risk’ to describe uncertainty with known outcomes and probabilities. Contrary to Knight’s value-neutral definition, however, in everyday use the word risk comes charged with negative connotations. More precisely, it carries the meaning of a chance to lose something of value, and I assume this meaning to be rather universally accepted since no discussions of risk as a concept seem to be found. Furthermore, there is ample evidence of the use of the word risk with its aforementioned negatively charged meaning in various domains of research, such as decision-making (e.g. Kahneman & Tversky, 1979; Fishburn, 1989; Loewenstein, 2001; Dew et al., 2009), entrepreneurship (e.g. Krueger & Brazeal, 1994; Baron, 2000; Xu & Ruef, 2004; McMullen & Shepherd,

2006; Hmieleski & Carr, 2008; Gifford, 2010; Monsen, Patzelt, & Saxton, 2010), and innovation (e.g. Christensen, 2005; Åmo, 2005; Hülsheger, Anderson, & Salgado, 2009; Rutherford & Holt, 2007; Alpkan, Bulut, Gunday, Ulusoy, & Kilic, 2010).

One could say that where uncertainty is more concerned about classification of outcomes and their probabilities, risk is used to characterise the likelihood and impact of *negative consequences* of those outcomes (Campbell, 2006). Where both the outcomes and their probabilities are known, one can use objective methods to calculate the amount of risk. The less known the probabilities are, the more subjective the risk assessment becomes.

In practice, however, people do not respond to risk like rational analysis would predict (Sunstein, 2007; Kahneman, 2011), but instead react to it emotionally (Loewenstein, Weber, Hsee, & Welch, 2001), and with different people perceiving the same amount of risk in different ways (Slovic, 1998; Slovic, Finucane, Peters, & MacGregor, 2004). The cognitive estimate of risk is affected by how we feel about risk, and how we feel about risk is affected by our cognitive estimate of it (Loewenstein et al., 2001; Slovic et al., 2004).

If we consider uncertainty and risk together, the less there is uncertainty the easier it is to estimate risk, and the closer we move towards Knightian uncertainty the more difficult it becomes. After all, how can you estimate the impact of something you are, by definition, not aware of in the first place? For example, it is not uncommon to measure risk of disastrous events in terms of people killed or injured, but the accident at the Three Mile Island nuclear reactor in 1979 did not result in loss of life. Instead, it had consequences that were entirely unanticipated and missing from traditional economic and risk analyses: stricter regulation on nuclear industry, which increased costs to build and run nuclear power plants, reduced operation of nuclear reactors worldwide, public opposition towards nuclear power, and reliance on more expensive energy sources. (Slovic, 1987.)

Dew et al. (2009) highlight the inapplicability of objective risk analysis methods in situations of Knightian uncertainty: While it might be possible to calculate risk in terms

of how much time, energy and resources one chooses to invest, in other words costs, it is impossible to calculate how much one *should* invest because Knightian uncertainty renders the upside, or benefits, virtually unknowable. In the end risk is always subject to uncertainty, and the reduction of perceived uncertainty should result in increased confidence to accurately estimate risk — both subjectively and objectively (Fiet, 1996; Alvarez & Barney, 2007; Loch, Solt, & Bailey, 2008).

3 MANAGING UNCERTAINTY

Although managing uncertainty may sound somewhat oxymoronic — after all, how would you manage something that is by definition unknown — there are stark differences in how well various project management approaches tolerate uncertainty, and to what extent they are able to incorporate uncertainties as essential parts of the projects themselves.

This chapter begins by describing three high-level approaches to dealing with uncertainty, followed by a comparison of different project management methods from the perspective of how they treat uncertainty. The experimentation-driven approach will be discussed in more detail, as it is the method that is best-suited for highly uncertain situations, while also being the method that was used by the two projects that are studied in the empirical part of this thesis.

3.1 SELECTIONISM AND LEARNING

According to Pich, Loch, & De Meyer (2002) there are three fundamental approaches to dealing with complexity and unforeseeable uncertainty: *Instructionism* is concerned about avoiding uncertainty altogether, or at best quantifying uncertainty and developing contingencies for dealing with it, which makes it unsuitable for situations where unforeseeable uncertainties exist, i.e. innovation. In other words, it can only cope with Knightian risk and ambiguity. This leaves *selectionism* and *learning* as the ways to proactively manage unforeseeable uncertainties, instead of avoiding or ignoring them. As for Knightian uncertainty, it by definition cannot be ‘managed’. Instead, one is recommended to use effectual logic of action (Sarasvathy, 2008), avoid situations where the existence of Knightian uncertainty exposes one to serious risks, and pursue

situations where Knightian uncertainty creates a potential for significant upside (Taleb, 2007).

Selectionism advocates the creation of multiple "candidate" projects, or variations of the planned solution, with the underlying assumption that the optimal outcome can be later selected from this pool of candidates. Learning approach aims to identify where potential unknown unknowns, or unforeseeable uncertainties might exist. It refers to a "flexible (unplanned) adjustment of the considered actions and targets to new information about the relevant environment, as the information becomes available." (Sommer & Loch, 2004, p. 1344.) This is achieved by utilising experimentation and other trial and error type learning activities to incrementally increase the project team's understanding of the situation.

In situations characterised by complexity and unforeseeable uncertainty, it is impossible to clearly define a project outcome, plan the causal steps needed to reach that outcome, and then execute according to the plan (Sarasvathy, 2001). Extreme examples of this would be the first engine-powered airplanes and the nuclear bomb. In these cases there could not have been a clearly defined outcome because much of the required basic science was missing at the time. It was only through a series of prototypes and trial-and-error experiments, learning step-by-step what works and what does not, that the details surrounding the desired outcome began to slowly take form. (Lenfle & Loch, 2010.)

Selectionism can take place sequentially or in parallel. It is worth noting, however, that sequential selection approach differs from iterative development in a way that subsequent candidates are not built on previous learning. Instead, each candidate is kept separate from one another. In the sequential model certain target criteria is determined in advance, and the first candidate to surpass that criteria will be selected as the solution. Whereas in parallel development approach the project with the best actual payoff, as observed afterwards, is selected as the solution. (Pich, Loch, & De Meyer, 2002.)

Selectionist strategies are best suited for situations where the cost of multiple trials is low and robust testing of solutions is possible. For example, testing in actual user environment is more robust than testing in a laboratory or other simulated environment, and likely to yield more accurate representation of actual performance. (Sommer & Loch, 2004.) One situation where selectionism is likely to work especially well is website development: It is easy and cost-efficient to test multiple variations of a website design, with real customers, and to find out afterwards which design yielded the best results (Iansiti & MacCormack, 1997; Davenport, 2009). Another good example of selectionism comes from a retail store environment: One company tested five different discount levels, ranging from zero to 35%, for their private-label items in order to shield their market share when national brands were on sale. It was discovered that using a moderate discount resulted in the highest increase in profits. (Anderson & Simester, 2011.)

In situations where unforeseeable uncertainties are present and only imperfect tests are available due to e.g. technical limitations or inaccessibility to the real user environment, the learning approach is more likely to give better results with less costs. Also, the more complex the environment is, the more likely it is that trial and error learning will outperform selectionism. This holds true even in situations where robust, perfect selectionist testing is possible. (Sommer & Loch, 2004.)

Where selectionism is subject to the costs involved in running multiple trials, learning costs are more related to the nature of experiments, required expertise, and the time and effort dedicated to screening the environment for unknown unknowns. For example, in a highly competitive environment where time-to-market is of the essence, it might be better to use a selectionist approach. The more complex and uncertain the environment, the more trials are needed in a selectionist approach, and the more experiments in the learning approach. (Sommer & Loch, 2004.) The number of experiments one should run, however, is also affected by diminishing returns on experimentation. At some point it is no longer feasible to conduct more experiments, as the expected learning stops justifying the costs (Thomke, 1998).

Lastly, it bears mentioning that selectionism and learning are not mutually exclusive. It is possible, for example, to run multiple candidate projects in parallel, with each project also using a trial and error learning approach. (Pich, Loch, & De Meyer, 2002.) The advantage of using both methods is that different candidate projects can learn from one another. Furthermore, the progress of candidates can be continuously evaluated and less favourable ones can be dropped early, while the promising ones can be allowed to continue. (Seidel, 2007.) For example, the Manhattan Project — which developed the first atomic bombs — used an approach similar to this, pursuing multiple candidate solutions in parallel, in trial and error fashion, even though it meant e.g. discarding two years of work on gaseous diffusion process in order to pursue another solution. This was made possible by emphasis on schedule rather than budget, and necessary due to the novelty of the whole project. (Lenfle & Loch, 2010.)

3.2 COMPARISON OF PROJECT MANAGEMENT APPROACHES

This chapter will review some of the more common project management methods, focusing on what kind of stance they take towards uncertainty — especially the unforeseeable and Knightian uncertainty, as those two are the most meaningful for innovative projects. These differences become evident when looking at how well different approaches allow uncertainty to affect the project goal or outcome, the process for achieving that goal, and how they treat contingencies.

3.2.1 The stage-gate approach

Perhaps one of the most commonly used project management methods is the stage-gate approach, which emphasises planning to eliminate uncertainty, control over the course of the project, and execution that happens in linearly proceeding sequential stages (Cooper, 1990; Lenfle & Loch, 2010). Critical creative activities such as defining project goals, assessing customer need, and creating a business case for the project happen either outside this model in a so-called feasibility study, or at the latest during the first stages where the activities and outcomes for the project are planned (Cooper, 1990; Iansiti & MacCormack, 1997; Tuulenmäki & Välikangas, 2011). It could be said that the logic of action used by the stage-gate approach is causal, due to its reliance on people's ability to predict the future and develop as good a plan as possible based on that prediction (Sarasvathy & Dew, 2005).

When it comes to uncertainties, the stage-gate approach treats them in an instructionist manner. It operates under the assumption that uncertainties can be discovered at the outset of the project, that their impact can be evaluated, and contingencies can be planned for them during the early stages of the project (Pich, Loch, & De Meyer, 2002; Lenfle & Loch, 2010). High risk projects simply reserve more time and resources, or dedicate more stages and gate reviews for these activities (Cooper, Edgett, & Kleinschmidt, 2002).

The stage-gate approach provides no inherent means for dealing with unforeseeable uncertainties, or unknown unknowns (Williams, 1999; Pich, Loch, & De Meyer, 2002), yet it is commonly used in innovative projects where uncertainty is high and surprises are likely to occur. This might at least partly explain why so many projects fail to either meet their goals, stick to the budget, or finish on schedule (see Matta & Ashkenas, 2003; Flyvbjerg & Budzier, 2011; Bloch, Blumberg, & Laartz, 2012). Even if a project was executed perfectly as planned, its outcome might turn out different than expected if some of the underlying assumptions for doing the project in the first place turn out to be incorrect (Iansiti & MacCormack, 1997).

3.2.2 Flash development & compression strategy

In flash development the goal is to execute the project as quickly as possible, with multiple stages taking place concurrently. The outcome of the project is defined at the outset and is not allowed to change. In fact, a clearly defined outcome is required in order to eliminate friction and to ensure that the project is moving in the right direction. It is also assumed that there is an *optimal* way to reach the outcome, and that it can be identified from the beginning. This will then make it possible to focus all energies on reaching the outcome as soon as possible. (Vandenbosch & Clift, 2002.) Similar to the stage-gate approach, flash development can be likened to the causation process (Sarasvathy, 2001), as the project outcome is taken as given and the focus is on finding the optimal means to achieve that outcome, followed by efficient execution.

Compression strategy is very similar to flash development in its emphasis on rapid execution. According to Vandenbosch & Clift (2002), the main difference between the two is that compression strategy uses a sequential approach to project stages instead of concurrent execution of multiple stages in parallel. In this sense it is similar to the stage-gate approach, except with faster execution of stages. This statement, however, contradicts with Eisenhardt & Tabrizi (1995), who Vandenbosch & Clift (2002) refer to as their source on compression strategy. The actual article says that "compression of product development steps involves not only shortening individual steps, but *also reducing the wait time between steps or even overlapping those steps*[4] (Stalk and Hout, 1990). Predictable steps can be overlapped because they are better known in advance, more tasks can be accomplished in parallel, and the waiting time between steps can be eliminated by overlapping these steps." (Eisenhardt & Tabrizi, 1995, p. 90.)

This would indicate that in the end there are no meaningful differences between flash development and compression strategy. However, according to how the compression strategy is characterised, it seems rooted in the stage-gate model and mentality of project management, focusing on planning in order to better understand the

[4] My italics.

development process; e.g. what needs to be done, how to sequence tasks efficiently, what resources are needed, when they are needed, and where to procure them (Eisenhardt & Tabrizi, 1995). To contrast this, flash development is more inclined to manage without certain formalities inherited from the stage-gate model, such as frequent gate reviews and other forms of "checks and balances" during the process, while putting more emphasis on real-time distributed decision-making and constant communication within the project team (Vandenbosch & Clift, 2002).

As for uncertainty, flash development has no means to deal with it, as it shifts focus away from the rapid execution of the project. Tremendous emphasis is put on the accuracy of the business case, or specification, since the flash development process has no means for changing it. Similarly the accurate planning of tasks and milestones is emphasised. What uncertainties there might be are assumed to be solved in preparation of the business case or specification. (Vandenbosch & Clift, 2002.) Likewise, compression strategy posits that product development is a series of predictable steps that can be clearly defined in advance (Eisenhardt & Tabrizi, 1995).

3.2.3 The flexible approach & experiential strategy

The key driver in flexible approach is to maintain options open for as long as possible. The project goal and outcome are defined at the outset, but it is acknowledged that the optimal way to reach that goal is uncertain (Tuulenmäki & Välikangas, 2011). In other words, we know where we want to go but not necessarily how to get there. Experiential strategies are based on similar assumptions: "product development is a highly uncertain path through foggy and shifting markets and technologies. The key to fast product development is, then, rapidly building intuition and flexible options in order to learn quickly about and shift with uncertain environments." (Eisenhardt & Tabrizi, 1995, p. 91.)

In contrast to purely sequential approaches where specific stages are dedicated for gathering feedback, flexible model emphasises the capturing of continuous feedback from users throughout the development process. This feedback is then used to guide the various development streams, such as design, testing, and integration. In other words, uncertainty is allowed to affect the execution of the project, as it is acknowledged at the outset that the optimal way to reach the project outcome is unknown. The aim is to capture a rich understanding of customer needs and alternative technical solutions as a project progresses, and to integrate that knowledge into the evolving specification. The faster a project can integrate that information, the faster that project can respond to changes in the product's environment. (Iansiti & MacCormack, 1997.)

This is very similar to the approach taken by experiential strategy, which emphasises multiple iterations, extensive testing for continuous feedback, and frequent milestones to both facilitate learning and to ensure that the project is heading in the right direction. Where the experiential strategy and flexible approach have a minor difference is that the former does not take a stand on whether project stages should be executed in sequence or in parallel, whereas flexible approach explicitly mentions the overlapping of different development stages (Iansiti & MacCormack, 1997). Experiential strategy also puts somewhat more emphasis on the development speed compared to the flexible approach (Eisenhardt & Tabrizi, 1995).

The challenge of both of these approaches lies in finding a good balance between the ability to make progress and remain open for changes as learning increases during the course of the project. As the project goes on, a growing number of aspects of the final outcome need to be locked from further changes. If this is done too early the risk is to end up with a sub-optimal outcome, but doing it too late results in unnecessary delays and costs (Thomke, 1998).

3.2.4 The experimentation-driven approach

Perhaps the most significant conceptual difference between the experimentation-driven approach and other methods for managing innovative projects — even those that recognise experimentation as a useful tool for learning — is that the experimentation-driven approach elevates experimentation from mainly a learning method into a vehicle that should ultimately guide the company strategy, business model, and behaviour (Barthélemy, 2006; Davenport, 2009; McGrath, 2010; Tuulenmäki & Välikangas, 2011; Hassi & Tuulenmäki, 2012).

This notion applies not just to innovative projects, but also to the creation of new businesses, as the experimentation-driven approach is closely related to the effectuation process used by expert entrepreneurs (Sarasvathy, 2001; Sarasvathy et al., 2010). In their study comparing causation and effectuation processes, Chandler, DeTienne, McKelvie, & Mumford (2011) identify experimentation as one of the key dimensions of effectuation. As stated by Sarasvathy et al. (2008, p. 340), "The effectuator seeks to design intelligent failures [in other words, experiments] that can be locally contained and contribute to his/her learning, and continually pushes forward a series of small successes that can be cumulated over time."

The experimentation-driven approach also follows the effectual principle of affordable loss (Dew et al., 2009): it can be used to learn from one's idea with minimum investment, focusing on available means and avoiding risking more than one can afford to lose. Also similar to effectuation, it takes a positive approach to contingencies and other unexpected events, as they provide learning opportunities and potentially vital information for the direction of the project. Both effectuation and the experimentation-driven approach emphasise action in the present as opposed to planning for the future. (Hassi & Tuulenmäki, 2012.)

Another characteristic that distinguishes the experimentation-driven approach from other project management approaches is that it allows for flexible goals and outcomes. The role of experimentation is not simply to test assumptions or gather feedback during

the development process, as in the case flexible approach or experiential strategy. Instead, experiments are used to generate new information, new ideas, and may even lead to the identification of entirely new opportunities. (Hassi & Tuulenmäki, 2012.)

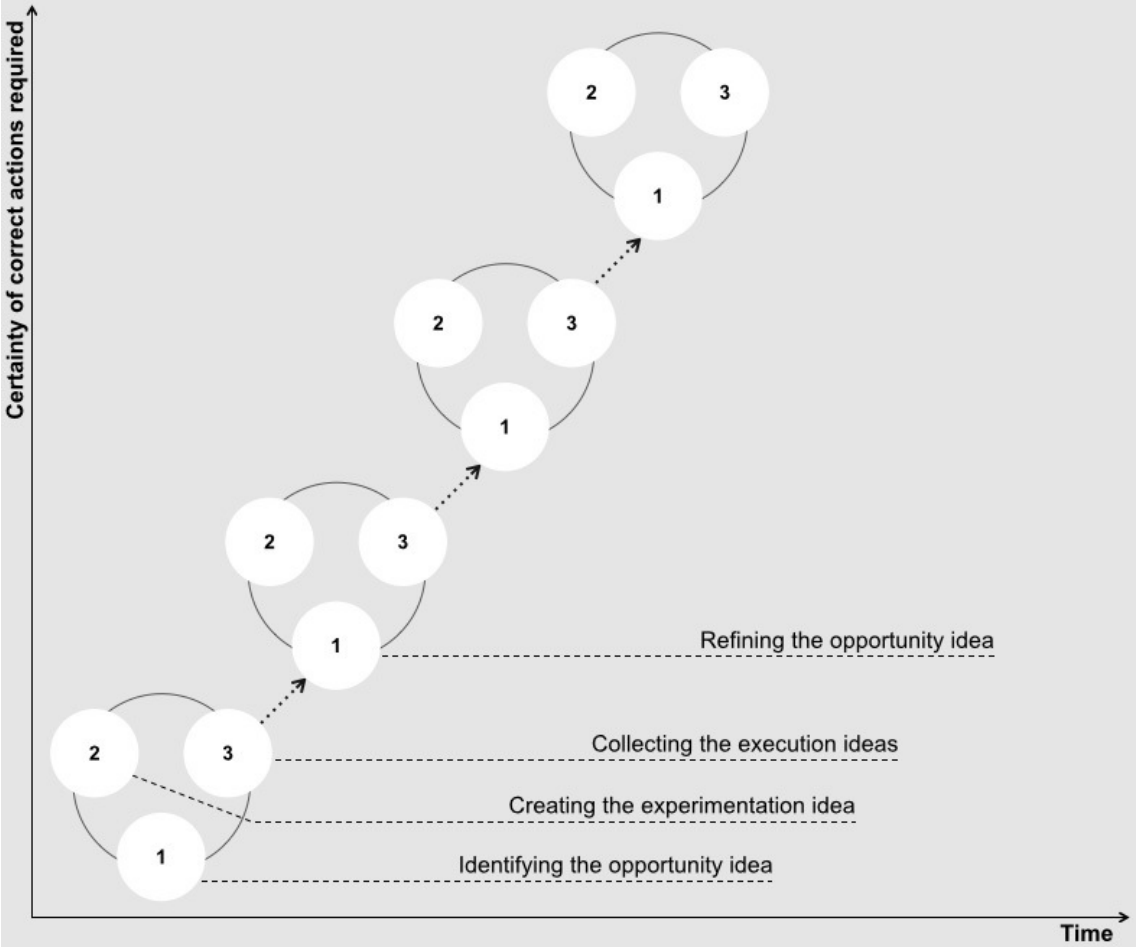
When complexity is high and uncertainties abound, surprises — both positive and negative — are inevitable. For example, the original goal may turn out to be based on false assumptions and ends up not worth pursuing. However, it is better to discover this early during experiments before more time and resources are invested. On the other hand, experiments can also reveal new possible outcomes with much higher feasibility and potential than the original ever had. (McGrath, 1999; Wiltbank et al., 2006.)

In the model of experimentation-driven innovation proposed by Hassi & Tuulenmäki (2012) there is no clear identifiable plan, nor are there predefined stages. Instead, there are three types of ideas (Figure 2) that outline the experimentation-driven process: One starts with an *opportunity idea*, which is an imagined solution to an identified problem, or something that could contribute towards reaching a desired goal. In the case of Zappos (Hsieh, 2010), the opportunity idea was an online shoe store. The founder had identified shoes as a potentially lucrative market that no one was yet serving on the Internet.

The traditional way to approach this opportunity would have been to create a business plan (Thornberry, 2002): to write down what kind of infrastructure and technology is needed, how the marketing is done, what are the 5-year cash flow projections etc. Instead, the founder took an experimental approach: He went to a local shoe store and asked the owner if he could take photos of shoes and put them online. If someone ordered a pair, he would then go buy it himself from the store and ship it to the customer. There was no back office and no IT infrastructure beyond a rudimentary website. However, this enabled the founder to find out if people are willing to buy shoes online in the first place. With this *experimentation idea* he was able to test the *critical assumption* (Sykes & Dunham, 1995) that could make or break the business: are people ready and willing to buy shoes online? In the process, he also learned about what kind

of payment options customers want, how do they want delivery to be handled, what kind of customer service is needed, and so forth.

Figure 2: Experimentation-driven innovation as a series of iterations with different idea types (Hassi & Tuulenmäki, 2012).



Lastly, the outcomes from experiments generate *execution ideas*, meaning ideas that have been validated and found to contribute towards reaching the desired goal or outcome. These are the lessons learnt — what should and should not be done — that will shape the original opportunity idea and accumulate through experiments to form the final design, plan, or specification. Hassi & Tuulenmäki (2012) characterise experimentation-driven innovation process as a series of iterations with these three idea

types. Experiments lead to new ideas and new untested assumptions, which lead to more experiments and ever increasing collection of execution ideas. For example, as IKEA discovered that people are willing to buy flat-pack furniture which they need to assemble themselves, a new opportunity idea emerged for using design to contribute to the packing and assembly. The underlying goal here was not a specific product or process, but to improve the execution of IKEA's strategy of offering a wide range of well-designed, functional home furnishing products at low prices. (Barthélemy, 2006.)

3.3 SUMMARY OF LITERATURE REVIEW

When innovation is the goal, it is by definition impossible to avoid uncertainty. It could also be argued that the more one attempts to eliminate uncertainty by sticking to what is already known, the more limited the possibility to create something innovative becomes. Yet the most commonly used project management approaches are ill-suited to dealing with uncertainty (Lenfle & Loch, 2010). The more uncertain the situation, the less emphasis should be put on predictive planning. As stated by Lee et al. (2004, p. 310): "Learning by experimentation is fundamental to solving problems for which outcomes are uncertain and where critical sources of information are nonexistent or unavailable."

As can be seen in Figure 3, different project management methods carry significant differences in how they tolerate uncertainty, whether they approach it proactively or reactively — if at all — and whether they treat contingencies and other surprises as something to be gotten rid of, or as something that can provide valuable learning. Of the methods presented here, the experimentation-driven approach is the most suited for situations where uncertainty is high and possibly of the Knightian nature. Likewise, the flexible approach and experiential strategy take a proactive stance towards uncertainty,

but in a more limited manner because they are committed to a predefined project outcome. On the opposite end of the spectrum are the flash development and compression strategy approaches, where execution speed is the goal and achieving it requires a complete elimination of uncertainty.

Figure 3: Uncertainty and different project management approaches.

	The stage-gate approach	Flash development & compression strategy	The flexible approach & experiential strategy	The experimentation-driven approach
Treatment of uncertainty	Uncertainties can be eliminated by thorough planning	No uncertainties are allowed whatsoever	Uncertainties are allowed to influence the execution details	Uncertainties are allowed to influence the execution details and project outcome
Treatment of contingencies	Contingencies are to be avoided, or incorporated into the plan	No contingencies are allowed whatsoever	Contingencies are managed by gathering continuous feedback throughout the development process	Contingencies are learning opportunities that should guide the execution and project outcome
Rigidity towards goals and outcomes	Project outcome can be locked-in after thorough planning	Project outcome is locked-in and known at the outset	Project outcome is locked-in and known at the outset	Project outcome is allowed to change over the course of the project
Rigidity towards execution	Execution details can be known after thorough planning	Execution details are locked-in and known at the outset	Execution details become known during the course of the project	Execution details become known during the course of the project
Logic of action	Causal	Causal	Causal for goals and outcomes, Effectual for the process	Effectual
Approach to managing unforeseeable uncertainties	Insructionism	-	Selectionism and Learning	Selectionism and Learning

4 RESEARCH METHODOLOGY

As discussed in the literature review, there are two main approaches to proactively managing unforeseeable uncertainty and complexity in projects: selectionism and learning. Conceptually the experimentation-driven approach can be positioned under learning, but to the best of my knowledge there are no studies that take a detailed look at uncertainty, and *how it is affected by the process of experimentation*. Due to this, it is reasonable to treat this research as an explorative step towards understanding changes in uncertainty in a practical, real-life setting. This main question can be further divided into the following:

1. How well can uncertainties be identified at the outset?
2. How can the identified uncertainties change as a result of experiments?
3. How do unforeseeable uncertainties reveal themselves through the process of experimentation?

In order to answer these questions, two experimentation-driven innovation projects were studied.

4.1 RESEARCH METHODS

A significant part of the research interest in this thesis is concerned about unforeseeable uncertainties, as the treatment of these is one area where the experimentation-driven and planning-based approaches seem to have their biggest differences. But how would one quantitatively measure something that, by definition, is unknown? The findings will show how many unforeseeable uncertainties the projects

were able to uncover by experimentation, but there is no basis for making any quantitative claims regarding how much is known and how much still remains unknown. Neither is it feasible to make quantitative claims about the significance of the findings, or put a number to how much uncertainty changed, as this would require knowing the upper and lower limits for significance — again made impossible by the existence of unforeseeable uncertainties. In other words, we can never know if what we think is the upper or lower limit will actually be the limit. Similarly, even if we think we have managed to reduce uncertainty to the minimum, a single unforeseen event or finding can change our perception completely. (Taleb, 2007.)

This together with the explorative nature of the topic means that using a qualitative approach becomes the more rational choice (Morgan & Smircich, 1980). Within the domain of qualitative research, the case study method can be used for both theory testing and theory building, and it can likewise be used as an interpretive research design, meaning that the constructs of interests do no need to be known in advance, but can be allowed to emerge from the data (Bhattacherjee, 2012). This thesis utilises case research in the form of an in-depth study of two experimentation-driven innovation projects.

Because the broader phenomenon under study — that is, experimentation-driven innovation — in the MINDexpe research project is not a common occurrence in organisations, an intervention was required in order to be able to study the phenomenon in a real-life setting. In this case, Mandatum Life purposefully wanted to introduce a new way to develop innovations into their organisation, and participating in the MINDexpe research project served the needs of both their organisational goals and our research interests. This *interventionist approach* (Argyris & Schön, 1989; Coughlan & Coghlan, 2002) brings forth action research as another, equally important, research design alongside the case study method.

Herr & Anderson (2005) describe action research as inquiry that is done by or with insiders to an organisation or community, in conjunction to some action or cycle of actions undertaken in the organisation. Instead of being neutral observers, as usual in

the regular, objectivist case study approach (Chalmers, 1999; Bhattacherjee, 2012), in action research the researchers will deliberately involve themselves in the context of the investigation, and are seen as key participants in the research process that is collaboratively undertaken with other interested or concerned parties (McKay & Marshall, 2001). In this case the role of us researchers was to facilitate workshops in the beginning to introduce the experimentation-driven approach to innovation, which were then followed by weekly tutoring sessions where we helped the teams to reflect on their progress and plan the next steps (see the next chapter for more details).

In the experimentation-driven innovation projects under study, each week between the tutoring sessions, starting from the initial workshops, can be seen as an action cycle consisting of four phases as described by Kemmis (1982 cited in Herr & Anderson, 2005):

1. Develop a plan of action to improve what is already happening (i.e. plan the next experiments)
2. Act to implement the plan (i.e. execute the experiments)
3. Observe the effects of action in the context in which it occurs (i.e. monitor and follow-up on how the experiments are proceeding, gather feedback)
4. Reflect on these effects as a basis for further planning and subsequent action (i.e. analyse the effects of the experiments and feedback from them)

Altrichter, Kemmis, McTaggart, & Zuber-Skerritt (2002) conceptualise action research as a situation where people reflect on and improve their own work and own situations, interlinking reflection and action, and making their experience public to those who are interested in and concerned about the work and the situation. It abandons the detached, objective and value-free approach to knowledge-generation in favour of an explicitly political, socially engaged, and democratic practice (Brydon-Miller, Greenwood, & Maguire, 2003). Furthermore, it explicitly aims at improving local

practice and organisational learning (Zuber-Skerritt & Perry, 2002), while at the same time creating knowledge that is transferable to other settings (Herr & Anderson, 2005).

Due to the explorative nature of the research question, an interpretive approach to data analysis, focused on theory building, is more suitable than a positivist approach, focused on theory testing. This is further supported by the nature of the phenomenon under study; when moving away from the objective domain of Knightian risk, measuring probabilities and estimating uncertainties becomes very much a subjective practice, and separating that from its social setting is questionable, especially considering that the aim is to understand the phenomenon in a real-life setting with all its confounding factors, as opposed to a more controlled environment. (Darke, Shanks, & Broadbent, 1998; Bhattacherjee, 2012.) For example, Sarasvathy (2008) has presented criticism towards Kahneman & Lovallo (1993) for treating future as consisting of predictable outcomes (controlled), while neglecting the possibility of the truly unknowable (real-life) in their studies on risk taking. This further support the use of action research together with a case study design, as the two approaches combined allows for studying the phenomenon in a real-life setting, and also support the use of interpretive data analysis in order to understand the research participants' subjective perspectives on uncertainties over the lifecycle of the two projects.

Because interpretive research is based on different set of ontological and epistemological assumptions about social phenomenon than positivist research, the positivist notions of rigour, such as reliability, internal validity, and generalisability, do not apply in a similar manner (Bhattacherjee, 2012). Likewise, the action research method has been criticised for being more similar to consultancy than proper scientific research, with problems when it comes to making causal connections and explanations from the findings. It has been accused of lacking scientific rigour, impartiality and discipline, and producing knowledge that cannot be generalised. (McKay & Marshall, 2001.) However, similar to interpretive research, action research should not be judged by the same criteria with which positivistic and naturalistic research is being judged (Herr & Anderson, 2005).

In order to address these concerns commonly associated with interpretive and action research, I aim to provide a systematic and transparent description of the data collection and analysis processes, and to describe the two projects and their findings using sufficiently rich portrayals of the events, enhanced with examples from the data.

4.2 DATA COLLECTION

The experimentation-driven innovation projects examined in this thesis were executed from start to finish with Mandatum Life, a Finnish insurance company in May-June 2013, with the first workshop taking place on May 6th, and the final presentations and closing of the project on June 5th. The company had chosen six employees from HR, Marketing, Communications, and Sales & Business Development to participate in an "Experimentation Sprint" organised by the MIND research group. Two teams of three were formed, with people from different units. Both teams were tasked to develop an idea and devise ways to experiment on it, focusing on what new information the experiments can teach about their ideas. Henceforth I shall refer to them as the Pit Stop team and the Decision Cards team, based on the ideas they chose to pursue.

I and another colleague from the MIND research group had an active role throughout the sprint. In the beginning we conducted two half-day workshops with the client teams: The first one was focused on the ideation process, during which both teams created a selection of ideas they could start developing. In the second workshop we introduced the experimentation-driven method and helped the teams to find a way to plan an experiment regarding their final idea.

The initial workshops were followed by hour-long tutoring sessions that took place once a week. Between the sessions the teams were tasked to conduct their experiments,

gather feedback, and analyse results. In the tutoring sessions we discussed what had been done so far, what could be done next, and prompted the teams to reflect on what they had learned in the process. There were altogether three tutoring sessions, followed by a closing session where both teams presented their journey from the initial ideas to final concepts, and discussed the process from the beginning to the end.

It should be explicitly noted that the role of us researchers was specifically to facilitate the initial workshops, as well as prod and prompt the teams in the tutoring sessions. We did not provide ready-made answers to the problems the teams faced, but rather tried to ask relevant questions to challenge their thinking. For example, one of the teams would have wanted a budget in order to procure certain items for their first experiment, so we had to challenge them to think of ways to do the experiment without spending any money.

Below is the detailed timetable of the Experimentation Sprint:

MAY 2013

Monday, 6th: Ideation workshop, both teams present (1pm-4pm)
Wednesday 8th: Experimentation workshop, both teams present (9am-12am)
Wednesday 15th: Tutoring session with both teams present (3pm-4pm)

Tuesday 21st: Tutoring session with Pit Stop team (12am-1pm)
Wednesday 22nd: Tutoring session with Decision Cards team (9am-10am)

Wednesday 29th: Tutoring session with both teams present (9am-10am)

JUNE 2013

Wednesday 5th: Final presentations and closing of the sprint, both teams present (9am-11am)

As for the collected data, this thesis relies mainly on two sources: semi-structured individual interviews (see the appendix for interview structure), as well as video recordings from each of the aforementioned tutoring sessions and from the closing session on June 5th. The interviews were conducted within two weeks after the final presentations and closing of the sprint by a third researcher in MIND (With the exception of one interview which was done by me due to scheduling reasons. This interview took place between the last tutoring session and the closing of the sprint.) who did not participate in any of the workshops or tutoring sessions, and thus had limited prior knowledge about what the teams had done, and no existing personal contact with any of the interviewees. The interviews were recorded and transcribed.

In addition to the interviews and videos, I had access to the teams' presentations, as well as photographic material taken by us during different workshops and tutoring sessions, and by the teams during their experiments.

All in all, the amount of collected data consists of:

- Six recorded interviews, averaging 70 minutes;
- 105 pages of interview transcripts;
- 129 minutes of recorded video from four different sessions;
- Two presentations, one from both client teams;
- 33 photographs.

In addition to the data listed above, I was also able to rely on my personal notes and observations, as I was present in every single workshop and tutoring session with the client teams. However, it should be also noted that the collected data will be used to pursue other research interests of the MIND research group, meaning that when the data was collected and interviews done, learning about uncertainty was not the only topic of concern.

The use of data in my analysis can be further divided into two rough categories: First, the transcribed interviews and recorded video were used primarily to identify

uncertainties and how they changed — in other words, to answer the research questions of this thesis. Presentations, photographs, and my personal observations were primarily used as support when describing how the two projects progressed over time.

4.3 ANALYSIS PROCESS

After the data collection was complete, it was analysed using the thematic analysis method, with the step-by-step process presented by Braun and Clarke (2006) as a guideline. Thematic analysis is closely related to grounded theory, but unlike grounded theory it does not explicitly intend to build theories about the social phenomenon that is being studied (Bhattacherjee, 2012). Instead, it is a method for identifying, analysing, and reporting patterns within data without being tied to any pre-existing theoretical framework. This allows thematic analysis to be used flexibly and without detailed knowledge of theoretical and technological knowledge of approaches such as grounded theory and discourse analysis. (Braun & Clarke, 2006.)

The use of thematic analysis in this thesis facilitated identification of uncertainties from the data, and supported the creation of more detailed descriptions of how these uncertainties were affected by the process of experimentation. What follows is an overview of the analysis process.

1. Coding of the videos

I watched through all the recorded video, pausing and making notes when the discussion turned into assumptions regarding the ideas the teams were working on, how those assumptions had been tested, and what had been learned about them. I also made

note of all mentions regarding new and unexpected findings that had surfaced over the course of the project.

As the videos were shot during each tutoring session and the closing of the Experimentation Sprint, they serve as a good indication of how the ideas of both teams evolved over time, and how the teams accumulated learning.

2. Coding of the interviews

As I read through all the transcribed interviews, I identified and extracted codes related to uncertainties and assumptions about the projects and the ideas they were pursuing. Same was done with codes related to new findings that surfaced during the projects, but were not identified at the outset. I also extracted codes where experimentation as a method and its relation to uncertainty was discussed. This last point is not specifically related to either of the projects, but on the experience the interviewees had regarding the use of the experimentation-driven method. All the extracts were copied into two documents, one for each project.

3. Initial categorisation

Based on the coded extracts from the interviews and the notes from the videos, I proceeded to create initial categories. These categories combined both sources of data under what I call *items of uncertainty,* with each category corresponding to one individual item, and containing all the coded extracts and notes from the videos where that specific item was being discussed. As before, the two projects were kept separate.

The reason for using the term ‘item of uncertainty’ is clarity: When the research participants talk about uncertainty, they rarely use the term uncertainty itself. Instead, uncertainties are inferable from various statements, assumptions, claims, and questions regarding the idea they are experimenting on. Using all these terms interchangeably to describe various uncertainties soon becomes confusing. This classification also facilitates answering to the main research question, as the item of uncertainty

categorisation helps focus on how each item was changed by the process of experimentation.

At this point I also separated extracts that were clearly related to experimentation as a method, instead of directly having to do with either of the two projects, putting these into their own category.

At the end of this step I had:

- Eight items of uncertainty for the Pit Stop project, plus a category containing background information regarding the project;
- Seven items of uncertainty for the Decision Cards project, plus one category containing background information regarding the project;
- One category containing extracts and notes regarding uncertainty and how experimentation as a method affects the way it is dealt with.

4. Creation of themes and refinement of categories

Based on the initial categorisation, four different themes emerged, with the same themes applying to both projects. Initial categories — i.e. items of uncertainty — were refined and distributed under the newly defined themes. Excluded from this were the categories for experimentation as a method, and the categories containing background information about the projects. The background information categories served as additional reference for writing the descriptions of the two projects. Experimentation as a method category I decided to leave out at this point as its contents, although interesting, had little to do with *how* uncertainty can change, but more about how the experimentation-driven approach affects the subjective *experience* of uncertainty — a topic which would warrant an entire research project of its own.

The themes, as named at the end of this step, were:

- Key questions;
- Execution details identified at the outset;

- Execution details unidentified at the outset;
- Other surprising learning outcomes.

As for the categories, there were nine for the Pit Stop project and 15 for the Decision Cards project. The reason for the increase was that in the previous step I had put all new learnings from a project under one category, whereas during this step I separated each learning point into a distinct item of uncertainty.

5. Defining the final themes and categories

The final step in the analysis consisted of writing the descriptions for each item of uncertainty, and how they changed over the course of the projects. These are detailed in chapter 5 on results and analysis. In the end there were eight identified items of uncertainty in the Pit Stop project, and 12 in the Decision Cards project. Some items from the previous step were dropped because the data pointing at them was somewhat ambiguous and not clear enough.

I also decided to refine the themes by leaving out the 'execution detail' description from the previous step, as its use would have resulted in some themes containing only one item of uncertainty, as well as some overlap between the themes. As a result of this step I ended up with three different themes which are equally applicable to both projects. Each of the identified items of uncertainty can be located within one of these themes:

1) Key items identified at the outset stands for items of uncertainty that can be positioned to the time when only ideation had been done. Furthermore, these are also items that have the power to make or break the idea. They are related to gaining access to experiment on the ideas in the first place, in other words getting initial buy-in, and items that are concerned about whether or not the ideas actually lead to the intended results.

2) Other items identified at the outset are similar to the items of uncertainty underneath the previous theme, with the exception that whether or not these hold true is *not essential* when it comes to the feasibility of the idea.

3) New learning items theme consists of all the items of uncertainty that were somehow surprising, unexpected, or not considered in the beginning of the project. At least based on how they were articulated in the video and the interviews.

5 RESULTS AND ANALYSIS

To describe the results and findings of the two projects, I start by a retelling of how the project teams progressed from ideas into experiments, how the experiments were conducted, and give examples of some of the findings from those experiments and how they affected the teams. This is then followed by a more detailed account of all the identified items of uncertainty, with selected extracts from the interviews and videos used as examples.[5]

Due to the nature of the claims, assumptions and statements where uncertainty is inherent, it would be impossible to give any objective estimates about the probabilities regarding the accuracy of those statements. Therefore the change in uncertainty for each item is presented by explaining how team members' subjective confidence regarding the validity of the items changed over the course of the project, and what lead to these changes in confidence. In the case of the new learning items, many of them were a result of evidence accumulated during experiments, meaning that when they became known the team members already had some degree of confidence in their validity.

5.1 PIT STOP PROJECT DESCRIPTION

For the Pit Stop team the initial idea was very small and concrete: they wanted to see if meetings could be improved by having a kitchen timer ring 10 minutes before the end, so the remaining time could be used for closing the meeting more effectively. In the second half-day workshop the idea evolved into a more ambitious goal: "To reduce meeting times while improving decision-making efficiency." From this goal the team created a concept for the Pit Stop meeting room.

[5] I have translated the video and interview extracts from Finnish to English.

The opportunity idea for Pit Stop consisted of having a designated meeting room where only 30 minute meetings can be reserved, which has no chairs but a standing desk, and where the meeting organiser needs to have a visible topic for the meeting, its goals, and agreed decisions. The underlying assumption was that these features would lead to achieving the goal of faster meetings with better decision-making.

When the team set out to experiment its idea they quickly found out that the meeting room they had originally envisioned for this purpose was booked with 2-hour meetings, and it could not be converted for the Pit Stop purpose. In fact, so were all the other meeting rooms. So instead of having a designated meeting room to run their experiments in, the team focused on testing if meeting times could be made shorter and decision-making improved by simply having a visible agenda for the meeting.

They recruited six meetings to the first round of experiments, talking to the meeting organisers personally and asking if they would be willing to try out the agenda and to cut 15 minutes from the scheduled meeting time. The agenda consisted of a flipchart that had sections for the topic of the meeting, its goals, and what decisions were made in the meeting. In the bottom of the flipchart were pictures of hands with thumbs pointing upwards, downwards, and sideways for quick feedback. All six gave thumbs-up.

The team also collected personal feedback from the meeting organisers, while explaining their idea of the Pit Stop meeting room in more detail. There was unanimous opinion that a real need to improve meeting efficiency exists, and people were optimistic that the Pit Stop concept would contribute in meeting that need. Furthermore, the agenda had been found useful for keeping the meeting on track, and some of the organisers were able to also reduce the meeting time.

Encouraged by the positive feedback the team was eager to move to the implementation of their concept. They wanted to start painting a room, getting furniture, buying a kitchen timer and an hourglass and so on. However, we insisted that they should do further experiments as there are still aspects of the idea they do not have evidence on, or that they could experiment with another opportunity idea that does not

involve a designated meeting room, but could still contribute towards reaching the original goal.

Grudgingly, the team ran experiments with a few more meetings. This time the focus was on seeing what people think of standing meetings, and having a mobile phone alarm ring 10 minutes before the end of the meeting. Surprisingly the team found out, after collecting feedback from the participants, that their initial idea of using a kitchen timer was seen as oppressive and annoying. The idea of using an hourglass received the same treatment. The most non-disruptive and discreet method of indicating passage of time was deemed to be a light switching on/off 10 minutes before the meeting time is over. They also discovered that soft carpets and standing meetings do not go well together.

5.2 PIT STOP FINDINGS

Key items identified at the outset

The idea will receive an initial positive response

This assumption was of critical importance because the Pit Stop team relied on getting meeting organisers to volunteer for their experiments: *"...I checked our Rumbuk-system which ... shows the meetings that are scheduled, we had decided to choose eight guinea pigs from there, and I called those who had one hour reservations, and asked if they want to be part of an experiment..."* If the reaction had been negative, it would have been a significant blow for their initial idea, and would possibly have required them to come up with a different approach to improve meetings.

As for uncertainty, it can be said that there was a fairly high level of confidence from the get-go that the idea will have a positive reception. This was based on the

notion that the team members had personally identified meetings as a problem area, and it was fair to assume that others in the organisation held similar opinions.

However, having to actually present the idea provided evidence for the assumption, showing that the need was recognised by others and giving validation and support to the concept of the Pit Stop meeting room: *"...there was a clear and strong message that more decisions and less idle chat are needed in meetings." "And everyone was really positive about the idea, thinking that there really is demand for it." "Positive reception. It was clear that everyone thought that finally, this is something we really need."*

=> Increase in confidence.

The idea will result in shorter meetings and improved decision-making

The second key item can be considered critical in a sense that it validates whether or not the Pit Stop concept can fulfil its goal. In general, the results of the experiments support this assumption. Especially the decision-making aspect improved: *"Going through decisions [made during the meeting] forces to clarify thinking." "Decisions, going through them as a part of the agenda ... helps make sure everyone understands what decisions were made."*

As for the reduced meeting time, there was mixed feedback and the caveat that there are also types of meetings, such as career development discussions, that should not be made "more efficient" to begin with: *"All [meetings] were not shorter. And we knew that the concept is not valid for all kinds of meetings." "Based on discussions [with meeting organisers] time savings and having a visible agenda were seen as the most positive aspects [of the idea]."*

Furthermore, it was found out that explicitly setting a time limit for the meeting, as well as having a visible framework (topic, goals, and decisions), may result in a change in people's behaviour, with everyone taking more responsibility about staying on topic

and ending the meeting on time: *"There was a much more efficient atmosphere [in the meeting] than normal."*

To summarise, it can be said that confidence regarding the validity of this assumption increased as a result of the experiments.

=> Increase in confidence.

Other items identified at the outset

Should passers-by see inside the Pit Stop room?

The team brought up the question of whether or not people walking past should be able to see what is going on inside the Pit Stop meeting room. They hypothesised that if others are able to see what is going on inside the meeting room, it might contribute to creating an atmosphere of quickness and efficiency: *"It should be the most visible meeting room so that there is external pressure to stick to the agenda…"*

This question was not tested in any of the experiments, nor was any other method of learning used to explore the topic. Therefore it can be said that uncertainty regarding this execution detail remains unchanged.

=> Not experimented, no change in confidence.

Can reservations be limited to 30 minutes?

This was a technical question that the team brought up in one of the tutoring sessions. The organisation uses an IT system for handling meeting room reservations and it was unsure whether or not that system could be configured to allow only 30-minute reservations. As for uncertainty, the team was inclined to believe that such a restriction would not be possible, but during the course of the project nothing was done

either to confirm or disconfirm that assumption: *"...the software probably can't prevent longer than half-hour reservations. But I don't know, it needs to be checked."*

=> Not experimented, no change in confidence.

Will the agenda be used as intended?

To contrast this with the key assumption regarding the overall efficacy of the Pit Stop concept, there was a degree of uncertainty about whether or not people would use the provided agenda as intended. The team had visioned that the meeting participants would actively use the template and write down the topic, goals, and decisions made during the meeting. The experiments showed that most of the users, but not all, used the agenda as the team intended: *"Not everyone wrote down the [detailed] agenda, but marked 'done done done' to indicate the different sections had been covered."*

=> Increase in confidence.

What kind of impact will the interior design have?

The team was rather concerned about how the Pit Stop room should look like, to the point that they were already planning to buy paint and a desk from IKEA. However, as the explicit purpose of the Experimentation Sprint was to test the ideas as cheaply and quickly as possible, no purchases were allowed. Therefore this execution detail remained untested, except for the surprise finding that soft carpets should not be used in standing meetings (see below): *"We have not yet tested how a stylish meeting room with nice furniture will appeal to people."*

=> Not experimented, no change in confidence.

A kitchen timer should indicate when meeting time is ending

The idea of using a kitchen timer or an hourglass, which lead to the development of the Pit Stop concept, remained an essential feature of the final solution. The team even looked at online catalogues and were determined to buy one. However, during the second round of experiments when they asked participants how they would react to having a timer in the meeting, the responses were not what was expected: people felt that a timer would only create a more oppressive, instead of a more productive, atmosphere: *"...hourglass was thought [by interviewees] as very oppressive, same with kitchen timer." "...we had a clear idea of using either a kitchen timer or an hourglass. ... Then, we got clear direct feedback that a timer ticking creates pressure in the situation, it is oppressive."*

The conclusion was that if there will be an indicator to sign that the meeting time is closing to its end, a light switching on/off would be the most suitable option: *"Best alternative was the light, which would switch automatically."*

=> Increase in confidence *against* the validity of the original assumption.

=> New alternative solution.

New learning items

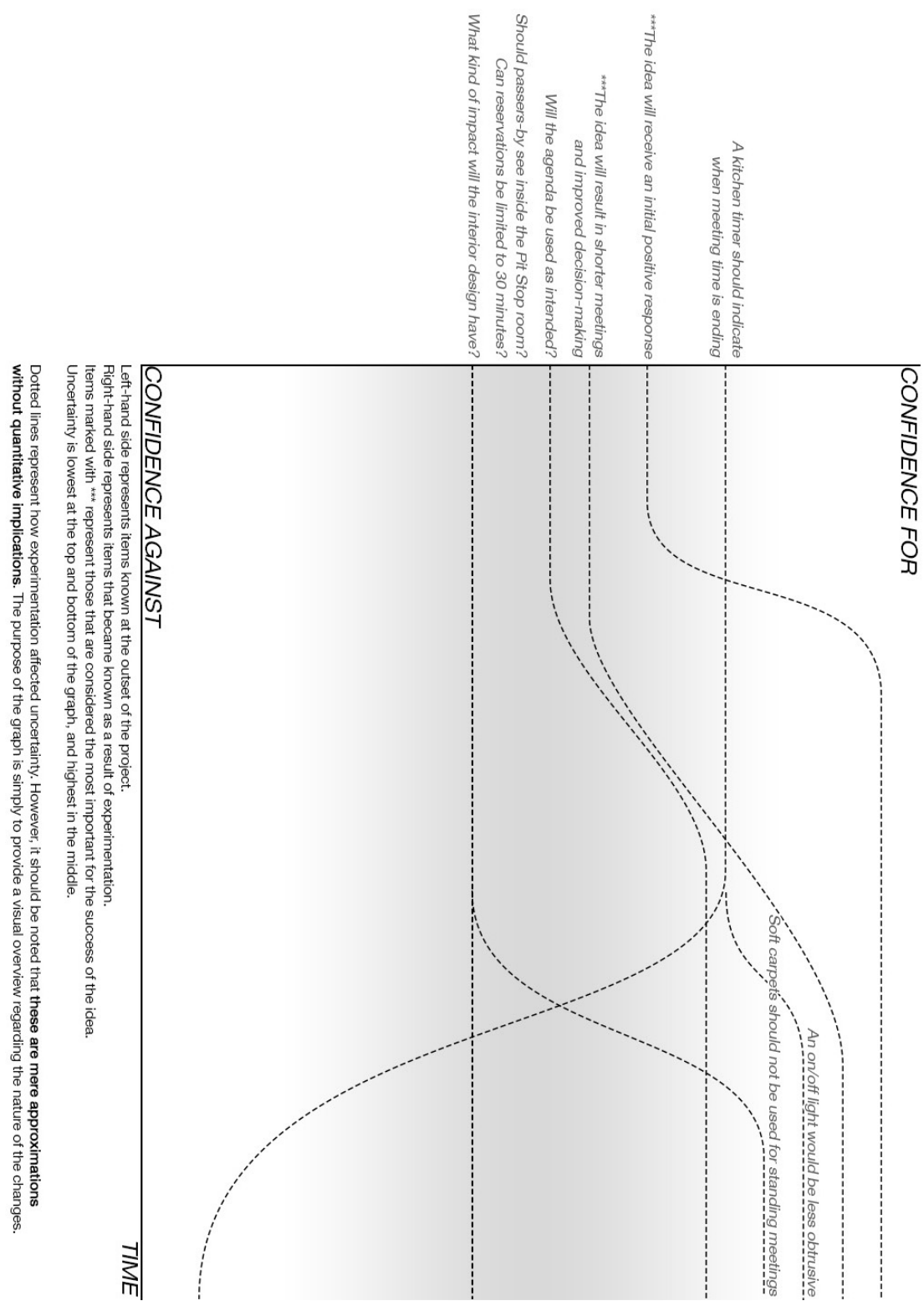
Soft carpets should not be used for standing meetings

A surprising finding came up when testing standing meetings in the second round of experiments: some women pointed out that standing while wearing high heels is mighty uncomfortable because the room where the standing meetings were tested happened to have soft carpets, and those carpets caused the heels to sink in and get stuck: *"Then we got feedback that this carpet is stupid, that you need to make sure if there is one in the meeting room, it has to be such that you can stand on it also with high heels."*

The team had not paid any mind to the topic of carpeting before this experience, but it quickly became evident that if the Pit Stop room was to accomplish its goal, this would be one of the execution details that need to be taken into account: *"...this kind of practical feature, which was a good indication that you need to test the final execution in detail."*

As can be seen in Figure 4, the Pit Stop group was able to validate the most critical identified items by running experiments, indicated by the increase in confidence regarding their validity. When it comes to using the kitchen timer, the reduction of uncertainty was of a negative kind: Instead of getting positive validation for the original assumption, they acquired evidence invalidating it. Even though elements regarding the interior design of the Pit Stop room were not directly tested, the standing meeting experiment resulted in new related learning, indicating that soft carpets should not be used in the meeting room.

Figure 4: Overview of the changes in uncertainty and new learning items in the Pit Stop project.



5.3 DECISION CARDS PROJECT DESCRIPTION

Contrary to the small and concrete initial idea of the Pit Stop group, the Decision Cards team was mainly preoccupied with topics related to bringing more common sense thinking into the day-to-day work culture. During the second half-day workshop the team decided to focus on the topic of decision-making. Their key assumption, or hypothesis, was that people will be more motivated when they are given more responsibility at work.

To test this assumption the team came up with the concept of Decision Cards: Each member in the HR and Marketing Communications teams — where the idea was to be tested — would be given five regular playing cards in the beginning of a week, with each card representing a single decision. In other words, everyone would not just be allowed but expected to make five decisions by the end of the week; decisions that would normally be taken to a supervisor for approval. Upon making a decision, the person would then attach the card and a post-it note explaining what the decision was on a wallchart. Lastly, it was instructed that each decision should be evaluated by whether or not it is beneficial for the company, its customers, and one's coworkers.

When the team presented the idea in HR and Marketing Communications, there was excitement about not having to double-check everything with the supervisor. Yet halfway through the week the wallchart was still occupied mainly by empty space. However, after some friendly nudging and reminding most of the cards ended up getting used by the end of the week. The decisions ranged from those dealing with long-term plans to ones that could be implemented immediately. For some employees it was easy to adapt the new behaviour of making decisions themselves, while others found it a bit more challenging. Mainly, however, the experiment managed to shine light to how cautiously people had been making decisions earlier, how it had contributed to making work seem burdensome, and had resulted in needless back-and-forth palavering.

When coming up with the idea for Decision Cards — and the topic of giving people more responsibility in general — the team felt the need for the intervention to exist

mainly in the Marketing Communications and HR teams. In fact, they outright stated that the idea would be a poor fit elsewhere in the organisation. However, armed with the positive experience from the first experiment, the team members started to change their perspective on the broader applicability of the idea.

In order to get some more evidence about whether or not the concept of Decision Cards could work elsewhere, they interviewed one worker and one supervisor in the Customer Service department. Surprisingly the feedback was positive, and with slight modifications to the number of cards and decision-making criteria the idea could also be tested there in the future.

5.4 DECISION CARDS FINDINGS

Key items identified at the outset

The idea will receive an initial positive response

Similar to the Pit Stop team having to recruit meeting organisers for their experiments, the Decision Cards team had to first get buy-in from the HR and Marketing Communications teams. In particular there was concern about whether or not the participants will understand what is asked of them, and why the team feels that their idea is important, that it will not be shot down before it even gets started: *"And [the idea] was received, I think, surprisingly well. I thought that people would wonder that it is somehow unclear, and that there will be a million questions, and the idea gets kind of killed by questions."*

Both team members responsible for presenting the idea for the HR and Marketing Communications teams voiced their uncertainty regarding the launch: *"Of course you*

think what if [the idea] is somehow unclear, or doesn't work at all in practice. ... I remember thinking over the weekend ... how will it go, or how will people react to it."

In the end, however, their concerns turned unwarranted as people got easily excited when they heard about the idea, openly exclaiming that they actually *want to* be able to make decisions about their own work: *"...we had a really good reception, people were saying that this is great, and that they want to make decisions..."*

=> Increase in confidence.

Distributed decision-making will increase, leading to increased work motivation

As with the Pit Stop idea, there is one critical assumption that will validate whether or not Decision Cards can fulfil its intended purpose: will the use of the idea increase distributed decision-making, and if it does will it lead to increased motivation at work?

If proven incorrect, this assumption could have invalidated the idea in two fronts: first, Decision Cards might not have lead to the desired change in behaviour, and even if the desired behaviour had been achieved, it might not have resulted in an increase in motivation. Even though after the first couple of days it seemed that nothing was happening, in the end of the first week most of the cards had been used: *"...people attaching cards on the wallchart , making decisions, I got the feeling that this really works."* This served as a clear indication that the use of cards lead to desired behaviour, as proven by the wallchart filled with cards and descriptions of decisions that had been made.

The second part of the assumption was also validated in subsequent team meetings and feedback discussions with participants: *"We did make independent decisions more." "...our team has a coffee meeting on Fridays, and there we looked at the wallchart and ... everyone explained what they had decided." "What the experiment taught us is that our hypothesis is true." "[the experiment] was considered good, and people said it*

somehow opened their eyes, how they had asked [approvals] where it should not be needed."

=> Increase in confidence.

Use of Decision Cards will lead to long-term change in behaviour

The third critical assumption for the Decision Cards team is related to whether or not a short-term use of playing cards as a reminder and proxy for decision-making will change behaviour even when the cards themselves are not in use anymore. In this sense the cards can be seen more like training wheels, with the end goal being that people will start making decisions without them.

There was some skepticism about whether or not this question can be answered in such a short time, but considering how quickly the teams adapted to making decisions on their own, and how quickly the cards themselves started losing their "glamor" while the behaviour itself remained, the team became more inclined to believe that even such a short intervention can lead to a long-term behaviour change. This was further supported by discussions with members in the HR and Marketing Communications teams: *"When people were later asked if [the experiment] had changed their behaviour, they said yes." "...pretty quickly it turned into, it was surprising how quickly it became part of a normal way of working in our team."*

These findings also lead the team to come up with the idea that if the decision-making behaviour starts to go back towards the old, passive mode, the Decision Cards method could be reintroduced in a campaign-like manner every now and then as a reminder: *"But I think it could be good to, have a week in the autumn, to see if decisions have somehow changed, but also to remind people [about freedom to make decisions]."*

=> Increase in confidence.

Other items identified at the outset

Will people abuse the freedom to make decisions?

The abuse of newly found freedom was one of the concerns the team raised before experimenting on the idea. In order to reduce the potential risk they created a decision-making framework, suggesting that each decision should be evaluated from the perspectives of the customer, the company, and co-workers. Nevertheless, there was no certainty about whether or not these guidelines would be followed.

In the end this fear turned out unwarranted, as everyone participating in the experiment used the freedom to make decisions in a positive and constructive manner. Furthermore, the risk of abuse was mitigated by the use of the wallchart where people reported their decisions for everyone else in the team to see: *"...we had no cases of overstepping boundaries, that someone would have decided something outside her own box. Or somehow abused this."*

=> Increase in confidence *against* the assumption that there would be abuse.

Decision Cards are not applicable outside HR and Marketing Communications

When the team was getting ready for the first round of experiments, they had a clear understanding that the idea is rather specific for the HR and Marketing Communications teams, as those are the two units where many decisions need to be made every day, and decision-making behaviour as-is was identified as a problem: *"...we were quite fixated that this will not work in the whole organisation, that it is just related to our unit."* However, as the initial experiment went better than expected, the team gained confidence that perhaps the idea could be used more widely in the organisation: *"Before I thought that absolutely not, this cannot be done [in the whole organisation], or that it just works for us. But then I realised, why not, this really works so well."*

Later they interviewed a manager and an employee in the Customer Service department, telling them about the Decision Cards idea. The idea was also discussed in other situations with members from elsewhere in the organisation. The feedback was unanimously positive, reinforcing the notion that the Decision Cards idea could receive broader use than initially assumed: *"We interviewed another business unit ... and told them about the experiment, and asked what they think about doing it there, and would there be need for it. And it became clear it could be done but with a lower number of cards, that maybe the decision-making is not that big of an issue in their unit." "...this interview with other business units, at that point I became more confident that we can make this work in the whole organisation."*

=> Increase in confidence *against* the assumption that the idea would not be applicable elsewhere.

New learning items

How to track if decisions will be put into action?

A new concern not voiced at the outset but only after the experiments was about tracking the decisions. It was realised that not all decisions are such that they can be put into action immediately. As a consequence, there was a discussion about whether or not there should be a way to monitor if decisions will also be followed through: *"...right now we have no way to follow-up on the decisions."* On the other hand, this issue applies only to some of the decisions. In the end nothing was done regarding this concern, but nevertheless it can be considered as a new learning item regarding the idea.

Distributed decision-making increases productivity

Even though the goal of Decision Cards was to increase motivation at work, it also had a positive side-effect of increasing productivity. When decisions could be made on the spot, many things that used to drag on were put forward without delay. For team members this meant not having to wait for a supervisor's approval, and for the supervisors this meant not having to spend time doing seemingly pointless approvals: *"What I think it caused in our unit was that [people] were faster to make things happen … They just did things they had previously thought need to be approved here, there, and elsewhere." "[the freedom to make decisions] made my work faster."*

Proactivity in improving work processes increases

Another positive side-effect of distributing decision-making power to the team members was that they took a more proactive role towards their own work. For example, there were spreadsheets and processes in use that many people considered useless, adding to workload without creating value. However, until the Decision Cards project no one had voiced their opinions about whether or not those processes could be changed or eliminated. Now that the decision-making power was given to the team members themselves, they took matters into their own hands, and agreed together to eliminate useless processes and refine those that were needlessly complicated or heavy: *"…we noticed some processes that, why do we have this Excel here instead of getting this information directly from there, I decided that here it goes [to end]."*

Trust between supervisors and their subordinates increases

When the experiment proved that team members are perfectly capable of making decisions themselves, and that no one abused the decision-making power, the team leaders felt that they can trust their team members with more responsibility. Seeing the increase in trust and benefits from not having to approve every single decision also got

the team leaders to reflect their own leadership behaviour; how come this kind of intervention had not been done before, and what in their leadership behaviour had caused people to be so cautious about making decisions: *"[the experiment] showed me as a supervisor that I can put trust on my team, that they can make the decisions themselves, that I am not needed in between as a rubber stamp." "...to critically evaluate your own work as a supervisor, that what have I done wrong to not have this kind of way of working implemented before, that why have people been so cautious about making [decisions]."*

Distributed decision-making increases teamwork

When supervisors were no longer needed to approve all the decisions, it made discussions regarding individual decisions between a supervisor and a subordinate more rare. In some cases, however, team members felt that they needed someone with whom to reflect their decisions. What happened was that the other team members replaced the role of the supervisor as a sounding board for ideas. Some decisions were still taken to a supervisor for discussion, but the final decision remained with the employee. The net effect was that team members started sparring and coaching each other much more than before: *"I noticed that when you don't need to get an approval [to a decision] anymore, you then ask your colleague, to get support that the decision will be good." "Wanting a second opinion ... increased the kind of sparring or brainstorming in the whole team."*

Visibility across job roles increases within the teams

A surprising side-effect of using the wallchart for tracking what kind of decisions people were making was that it also increased visibility within the team into what kind of job roles other people have, and what kind of decisions they are dealing with in their day-to-day work. Same effect held true also between supervisors and subordinates, with visibility increasing both ways: *"...perhaps the value lies there, that I tell my team*

members that this week I have done these decisions, and then they learn, know a bit more about what that supervisor is doing when you see her so rarely." "As everyone has a bit different role [in the team], you learn 'ah ok you have made that kind of decision.'"

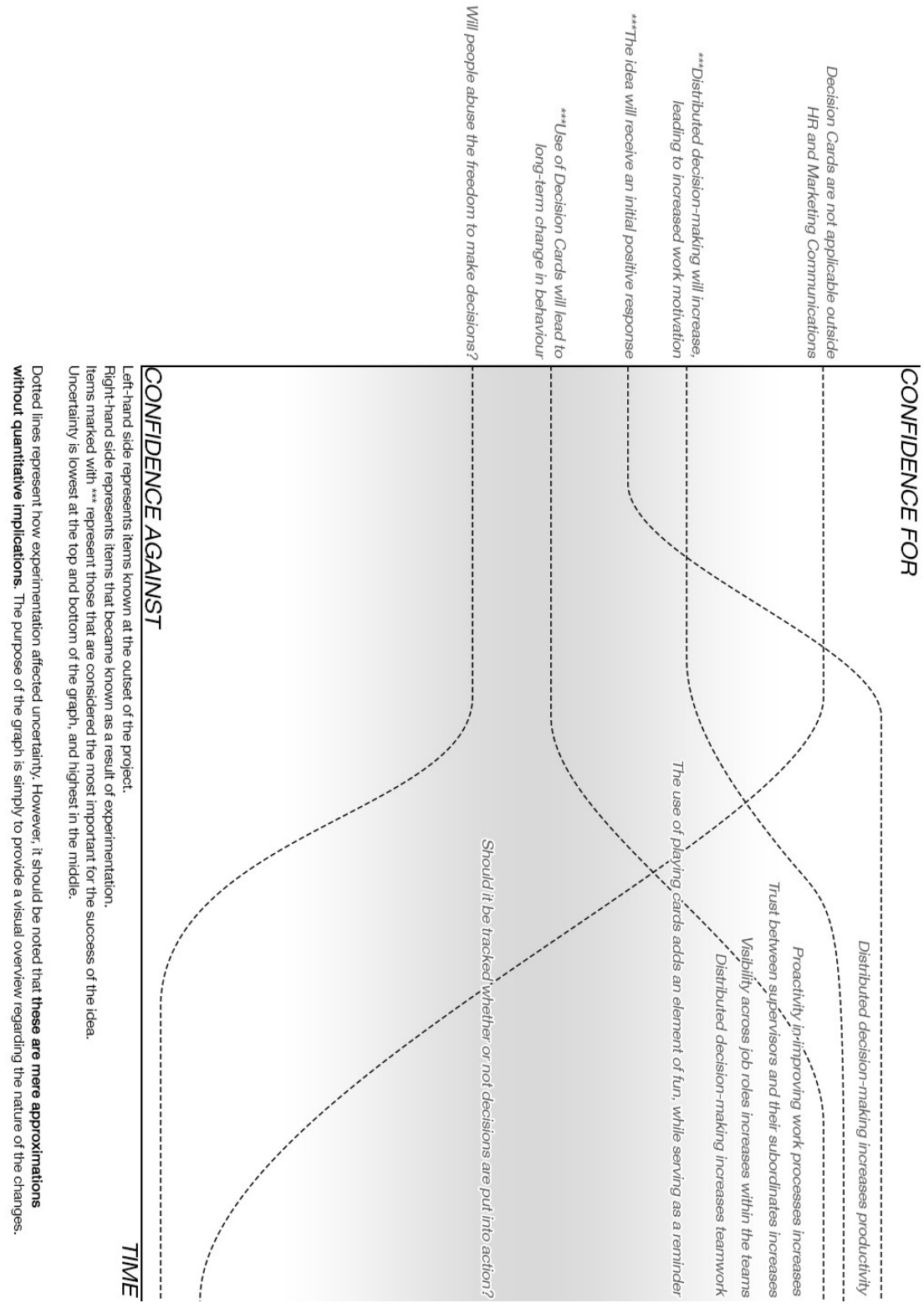
The use of playing cards adds an element of fun, while serving as a reminder

Initially the idea for giving out five playing cards for each team member, with each card representing one decision, was conceived because the team wanted to make the idea of five decisions feel more tangible. During the experiments, however, it was found out that cards themselves added an element of playfulness into the whole process. Decision making itself lost some of its seriousness and made it more approachable. Furthermore, having something concrete — in this case the playing cards — turned out to be a powerful reminder about the freedom to make decisions. People were not hiding the cards inside their desk drawers, but instead kept them out in the open: *"It helps to have something concrete, in this case the playing cards, on the desk reminding that okay you have the freedom to make decisions. And that it can be seen afterwards that decisions have been made." "During the two weeks we, as supervisors, started saying 'use the card' when someone came to ask about making a decision." "The cards… worked surprisingly well because it made the whole ordeal fun, and everyone took it more playfully than… if there had been something like an Excel sheet for tracking and reporting decisions."*

Figure 5 shows how every item identified at the outset of the project faced reduced uncertainty as a result of the experiments. The items that can be considered most critical for the idea received positive validation, whereas the concern over abuse of freedom to make decisions, and the initial assumption about the inapplicability of the idea elsewhere in the organisation were invalidated by the evidence.

Furthermore, it can be seen that experiments resulted in a significant amount of new learning. Most of these learning points already had supporting evidence when they surfaced, with the exception of whether or not putting decisions into action should be tracked, and as this point was not explored further, it still remains relatively uncertain.

Figure 5: Overview of the changes in uncertainty and new learning items in the Decision Cards project.



5.5 SUMMARY OF RESULTS

As we can see from the findings, uncertainties regarding the original ideas were identifiable at the outset. Some of them can be seen as critically important for the validity of the idea, and others can be seen as features or details concerning the execution of the idea. In both projects experiments lead to reduction in uncertainty regarding these initial assumptions by means of confirming or disconfirming evidence. In the Pit Stop project we can see how evidence disconfirming an initial assumption also lead to the formulation of a new assumption, with the same evidence also serving to increase confidence that the new assumption holds true. On the other hand, it can be said that not all of the identified uncertainties changed, as no new learning about them was accumulated.

In both cases the experiments resulted in creation of knowledge that was not identified at the outset. In the Pit Stop project there was the finding about soft carpets in standing meetings. In the Decision Cards project altogether seven new learning items were identified, most of them together with evidence increasing confidence in their validity.

6 DISCUSSION

Considering the difference in the amount of new learning items between the two projects, it raises the question about whether or not ambiguity regarding the idea at the outset has an impact on how much new learning can be acquired by experimentation. The Pit Stop team had a very concrete vision of the meeting room already before any experiments had been done, whereas the Decision Cards team had a much more vague idea about what might happen when they introduce the cards, how people would react to them, and how they would be used. It could be said that with Decision Cards there may have been more room for new knowledge to emerge.

I find this an interesting notion worth mentioning, even though it is too early to draw any conclusions based on such a limited comparison. It would, however, support the idea that uncertainty has a limiting role when it comes to the potential to innovate: the more uncertainty is allowed, the more options remain open for creating something truly novel, whereas the more limited the options are in the beginning — as demonstrated by the Pit Stop project — the less there is room for innovative outcomes to emerge.

6.1 ON ESTIMATING UNCERTAINTY

In the literature review the following definitions for uncertainty were presented:

- *Knightian risk* when the outcomes and their probabilities both are objectively known;
- *Ambiguity* when the outcomes are known but their probabilities are unknown *ex ante*;
- *Unforeseeable uncertainty* when the outcomes are unknown *ex ante;*
- *Knightian uncertainty* when the outcomes are inherently unknowable.

In the case of Knightian risk it is possible to use objective probability estimates. Ambiguity assumes that probabilities can be calculated *ex post,* essentially turning the previously ambiguous situation into one where objective estimates of uncertainty become also possible. However, what about a statement such as "use of Decision Cards will lead to long-term change in behaviour"? We can clearly identify two outcomes: true and false. However, even after gaining evidence through experimentation that the statement is more likely to be true than false, we are none the wiser to give an *objective* probability estimate for it.

We could use subjective probabilities, and by using a method such as Bayesian probability analysis (e.g. Berger, 1985; Chalmers, 1999; McGrayne, 2011; Silver, 2012), we could revise the initial subjective probability estimates as accumulating evidence leads to reduced uncertainty, resulting in more and more accurate estimates of probability. However, not even the Bayesian method can turn a subjective probability estimate, no matter how accurate it is, into an objective one. Furthermore, these estimates remain vulnerable to dramatic changes that can be caused by a single unexpected event, meaning that we could never be truly certain about the accuracy of our estimates (Taleb, 2007).

A more serious problem in estimating uncertainty has to do with the nature of the statements, claims, and assumptions themselves (Lane & Maxfield, 2005). Between the black & white absolutes there are shades of grey; "use of Decision Cards will lead to long-term change in behaviour" is not, in reality, a simple yes/no proposition, but affected by an unknown number of if-but-then's, however's, and other exceptions and clarifications.

When it comes to even seemingly simple propositions such as whether or not "a kitchen timer should indicate when meeting time is ending", there is a universe of confounding variables that may affect the conclusion: Meeting rigour and adherence to it is likely to be affected by the organisational culture, which in turn is affected by a multitude of factors. Kitchen timer itself may bring up different connotations for

different people, and having the meeting end up in time might also be of varying importance, depending on the meeting in question and the people involved.

Unlike sterile gambles used in much of research on decision-making under uncertainty (see e.g. Kahneman & Tversky, 1979; Loewenstein, 2001; Lehrer, 2009; Kahneman, 2011), real-life decision situations are context- and time-dependent, and characterised — at least to a degree — by the effectual problem space of Knightian uncertainty, goal ambiguity, and isotropy (Sarasvathy et al., 2008). For example, the above statement regarding a kitchen timer might only hold true in a particular organisation, or with a particular group of people. Furthermore, it cannot be said for certain that if the statement holds true today, it will also hold true one year from now. Perhaps one year is enough to get people hating the sound of a kitchen timer. Lastly, it would be impossible to predict if and when a technological innovation might occur that will have an impact on the desirability or effectiveness of a kitchen timer.

In the end it seems that when it comes to real-life decision-making situations where outcomes or their probabilities cannot be objectively classified, unforeseeable and Knightian uncertainties are either directly or indirectly having an effect. Even if we can classify the outcomes from a primary statement such as “use of Decision Cards will lead to long-term change in behaviour”, we cannot classify all the possible factors that may have an effect on the probability of that statement, or what are all the necessary clarifications and conditionals regarding the statement itself. Nor can we necessarily see all the secondary effects that are created by the statement being true or false.

Perhaps the most striking finding from this research is that even though both of the projects were seemingly simple and limited in scope — one about behaviour change and one about designing a new meeting room concept — as opposed to anything even remotely radical, unforeseeable uncertainties were not only discovered, but they were also of significant importance. For example, if the Pit Stop meeting room concept were to be implemented with soft carpets, without understanding that they make standing difficult, the room might soon end up unused. Even worse, without the insight on the importance of using a different kind of carpet, this could lead the project team to

erroneously conclude that the whole concept does not work, whereas in reality the problem lies in an execution detail. In the case of Decision Cards, a number of unanticipated positive effects were identified as a result of the experiments, greatly increasing the perceived value of the original idea.

In short, the existence and impact of unforeseeable uncertainty seems worth considering not only in the context of highly innovative and novel projects, but also in the case of those that are relatively mundane.

6.2 COMPLEXITY AND NONLINEARITY

Organisations are complex systems that exhibit nonlinear behaviour, meaning that a small change in even a single parameter can result in drastic changes in the behaviour of the whole system (Anderson, 1999). The findings of this thesis suggest that experimentation can be used to uncover these kinds of nonlinearities in real-life situations, as demonstrated especially by the Decision Cards project. Objectively speaking the "change in parameters" was nothing more than giving five playing cards to each person, and the permission to make decisions with those cards. Yet such a small change resulted in observable increases in productivity and motivation, building of trust within the teams, proactivity in improving work processes, transparency, increase in teamwork etc.

Interestingly, as experimentation by definition aims for learning about a topic with as little time and resource investment as possible, it is shielded from inverse nonlinear effects. In other words, experimentation creates opportunities to uncover small changes that create large effects, but avoids the risk of introducing large changes resulting in little to no effect. By contrast, traditional planning models are vulnerable to these kinds of nonlinearities where large, and usually expensive, changes may end up having no

measurable impact at all. For example, a McKinsey survey of U.S. And European companies revealed that two thirds of more than two year old Total Quality Management programs had died due to a lack of results (Cameron, 1997). In another survey on effectiveness of process and procedure re-engineering in organisations, 85 percent of the respondents reported little or no gain from the effort (Cameron & Quinn, 2011).

The practical implications of this are quite significant. The complex adaptive systems point of view dictates that no two organisations are exactly alike. Furthermore, these systems are bound to change over time. (Gell-Mann, 1994; Anderson, 1999; Carroll & Burton, 2000.) This presents a serious limitation regarding the direct transferability of processes, methods and so-called best practices, and might partly explain why haphazard copying of management innovations such as the Kan-Ban system and quality circles rarely result in desired performance improvements (Senge, 2006). Adopting a more experimentation-driven approach to organisational changes, as demonstrated by the Decision Cards case, might help circumvent many of these issues while also saving a significant amount of time and resources.

7 CONCLUSION

Uncertainty is an inescapable part of the reality of human existence. It is an essential characteristic of the future (Read, Song, & Smit, 2009), it makes us fabricate erroneous explanations of past events (Menashe & Shamash, 2005; Taleb, 2007), and it overshadows our ability to make decisions in the present (Camerer & Weber, 1992; Loewenstein, 2001). Situations such as managing innovative projects or developing new business ventures are especially prone to uncertainties that may or may not be classifiable at the outset, yet carry a significant impact for the final outcome. It is therefore essential to develop strategies to *proactively* manage uncertainty, and to acknowledge the limits of our ability to predict the future. Such strategies include effectuation as a model of rational decision-making, selectionism and learning as high-level approaches to managing unforeseeable uncertainties, and the experimentation-driven approach — or, to a lesser extent, the flexible approach or experiential strategy — for managing projects.

There are a number of studies examining decision-making under uncertainty in economics and behavioural sciences. Effectuation has created a lot of attention in the field of entrepreneurship, and similarly the aforementioned project management approaches have been discussed in books, magazines, and academic journals. I was, however, unable to find publications where individual items of uncertainty had been tracked over the course of a development project. For example, Sommer & Loch (2004) show using mathematical simulations how selectionism and learning can lead to the discovery of unforeseeable uncertainties, and Seidel (2007) shows how product concepts change during a development process, but does not explain the underlying uncertainties and changes in them as product development teams accumulate learning. The aim of this thesis was to fill that gap.

The two experimentation-driven projects analysed demonstrate how uncertainty can be a concern even in seemingly simple and small attempts at creating something new. Furthermore, the findings of this research show that experimentation can be used to

quickly learn about those uncertainties, and also to uncover unforeseen items that may have significant importance for the original ideas and concepts. Finally, to shed some light to *how exactly do uncertainties change* over the course of a development project, more detailed accounts were used to describe each identified item of uncertainty, and to explain how new items were uncovered in the two projects.

7.1 VALIDITY AND RELIABILITY OF THE RESULTS

According to Herr & Anderson (2005), action research should be evaluated by using the following five items as a guideline:

1. Did the research generate new knowledge?
2. Were action-oriented outcomes achieved?
3. Did the research result in participants' deeper understanding of the phenomenon?
4. Were the results of the research relevant to its local setting?
5. Was a sound and appropriate research methodology used?

To shortly address these five questions, I shall reiterate that this research has found and addressed a research gap by increasing our understanding of how uncertainties can change through a process of experimentation-driven innovation. The interventionist approach used in this research, combined with the results from the two projects, created actual changes in the client organisation, whereas ongoing reflection and discussions throughout the Experimentation Sprint served to facilitate learning. The relevance of the results should be evident from chapter five, whereas the methodological choices are discussed in more detail in chapter four.

As the aim of this research was to see how uncertainty can change as a result of experimentation, I am not making any statements regarding the frequency or significance of those changes. Neither is my purpose to create full-fledged theoretical models, or to explain the subjective experience of uncertainty. For this purpose the interpretive case study method works well, as it helps identify *how* uncertainty can change, or in other words what *types* of changes happened in the projects, and even a single occurrence of a specific type of change is sufficient to confirm its existence.

As for the quality and credibility of the source data, it helps to have not just transcribed interviews but also videographic material recorded over the course of the projects. The videos show how teams progressed week by week, providing a more reliable description of events as they unfolded, instead of having to rely purely on how participants remembered the events during the interviews. Also having interviews from each member of the two teams helps in part to ensure that their descriptions of events are consistent.

Considering the unforeseeable uncertainties that were uncovered during the experimentation process, it needs to be considered whether or not at least some of those uncertainties could have been already classified beforehand by us having used different kinds of tools and methods in the workshops, or dedicating more time at the outset for exploring the assumptions underlying the teams' ideas. In other words, it cannot be said how much of the 'unforeseeability' is due to the uncertainties themselves, and how much is due to the process used in the Experimentation Sprint.

Nonetheless, even if some of these uncertainties had been identified earlier, they would still be subject to same subjective probability estimates, lacking evidence regarding their validity until actual experiments would be done. This brings forth the issue of costs. One of the arguments supporting experimentation and other learning-oriented methods is that they can often create missing information faster, cheaper, and with better validity than what can be achieved by relying on planning alone (Sykes & Dunham, 1995; Pich, Loch, & De Meyer, 2002).

7.2 PRACTICAL IMPLICATIONS

Prior research has shown that experimentation is fundamentally important for solving problems in situations of uncertainty or incomplete information, and as such there is no reason to question its role in highly innovative projects (Lee et al., 2004; Lenfle & Loch, 2010). Similarly Pich, Loch, & De Meyer (2002) have demonstrated that selectionism and learning can be used to manage complexity and unforeseeable uncertainty. However, from the practical point of view understanding *how* uncertainties can change as a result of experimentation may help develop better tools and methods for managing innovative projects, and the MIND research group is already taking steps towards this goal.

This thesis also vividly shows that uncertainties are not just limited to highly innovative contexts — something that seems to have escaped notice in much of the prior research on the subject — but can have a significant effect on the outcome of even seemingly mundane projects. This highlights the importance of not relying solely on planning-based approaches, even in situations that appear relatively straightforward at the outset. Also considering the predominance of various planning-based methods in managing projects, it would be wise for project managers to familiarise themselves with alternative tools and methods that utilise effectual, as opposed to causal, logic of action in order to be better prepared for dealing with uncertainty and unpredictability.

Lastly, when a project is trying to have an effect on a complex system — e.g. an organisation — being aware of the existence of nonlinearities and using tools such as low-cost experimentation can help discover areas where small changes may lead to disproportional results. Furthermore, using the experimentation-driven approach will also help avoid wasting resources in large-scale transformation efforts that may end up having no measurable impact at all.

7.3 SUGGESTIONS FOR FUTURE RESEARCH

The ways for uncertainty to change as suggested by this thesis should not be treated as a complete, exhaustive list. It would be misleading to claim that the types of changes discovered here contain all the possible ways uncertainty can change. Additional research is needed to attain this result with better confidence. What this thesis provides, however, is the way to see uncertainty as an inherent component of the assumptions, claims and statements we make regarding reality, measured by our confidence in the validity of those assumptions. I believe this approach will be helpful for future research attempting to explain changes in uncertainty.

The real measure of the usefulness of the experimentation-driven approach in managing uncertainty would be to compare multiple innovative projects, using different project management approaches, and study if tangible benefits can be achieved by treating the goals, ideas, and concepts pursued by the projects as consisting of assumptions, claims and statements — or items of uncertainty. Each item could then be evaluated by how important it is for the idea itself, and how uncertain it is based on the current knowledge. This would essentially inform the project team about which assumptions they should attempt to validate first, which again would guide the types of experiments that need to be done. Finally the project management approaches could be evaluated against each other by their outcomes, process, speed, resource expenditure, or other success criteria.

Similarly it would be interesting to see a comparison of various project management approaches, both causal and effectual, from the perspective of their ability to discover and take advantage of nonlinearities. Considering that complex systems are characterised by counterintuitive and surprising behaviour that is hard to predict (Casti, 1994), it would be reasonable to expect that in such situations the non-predictive project management approaches will result in superior performance.

References

Alpkan, L., Bulut, C., Gunday, G., Ulusoy, G., & Kilic, K. (2010). Organizational support for intrapreneurship and its interaction with human capital to enhance innovative performance. *Management Decision*, Vol. 48, No. 5, 732-755.

Altrichter, H., Kemmis, S., McTaggart, R., & Zuber-Skerritt, O. (2002). The concept of action research. *The Learning Organization*, Vol. 9, Iss. 3, 125-131.

Alvarez, S. A., & Barney, J. B. (2007). Discovery and creation: alternative theories of entrepreneurial action. *Strategic Entrepreneurship Journal*, Vol. 1, Iss. 1-2, 11-26.

Anderson, E. T., & Simester, D. (2011). A step-by-step guide to smart business experiments. *Harvard Business Review*, March 2011, 98-105.

Anderson, Philip (1999). Complexity Theory and Organization Science. *Organization Science*, Vol. 10, No. 3, 216-232.

Argyris, C., & Schön, D. A. (1989). Participatory Action Research and Action Science Compared: A Commentary. *The American Behavioral Scientist,* Vol. 32, No. 5, 612-623.

Arthur, W. Brian (1989). Competing technologies, increasing returns, and lock-in by historical events. *The Economic Journal*, Vol. 99, No. 394, 116-131.

Arthur, W. Brian (1999). Complexity and the Economy. *Science*, Vol. 284, 107-109.

Atzori, L., Iera, A., & Morabito, G (2010). The Internet of Things: A survey. *Computer Networks*, Vol. 54, Iss. 15, 2787-2805.

Baron, Robert A. (2000). Psychological Perspectives on Entrepreneurship: Cognitive and Social Factors in Entrepreneurs' Success. *Current Directions in Psychological Science*, Vol. 9, No. 1, 15-18.

Barthélemy, Jérôme (2006). The Experimental Roots of Revolutionary Vision. *MIT Sloan Management Review*, Vol. 48, No. 1, 81-84.

Berger, James O. (1985). *Statistical Decision Theory and Bayesian Analysis*. New York: Springer-Verlag.

Bhattacherjee, Anol (2012). *Social Science Research: Principles, Methods, and Practices*. [Online] Open Access Textbooks. Book 3. Available at: <http://scholarcommons.usf.edu/oa_textbooks/3> [Accessed 30 November 2012]

Blatt, Ruth (2009). Resilience in entrepreneurial teams: Developing the capacity to pull through. *Frontiers of Entrepreneurship Research*, Vol. 29, Iss. 11, Article 1.

Bloch, M., Blumberg, S., & Laartz, J. (2012). *Delivering large-scale IT projects on time, on budget, and on value.* [Online] McKinsey & Company. Available at: <http://www.mckinsey.com/insights/business_technology/delivering_large-scale_it_projects_on_time_on_budget_and_on_value> [Accessed 6 August 2013]

Braun, V. and Clarke, V. (2006) Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3 (2). pp. 77-101.

Brown, S. L., & Eisenhardt, K. M. (1998). *Competing on the edge: Strategy as structured chaos.* Boston, Massachusetts: Harvard Business School Press.

Brydon-Miller, M., Greenwood, D., & Maguire, P. (2003). Why action research? *Action Research*, Vol. 1, No. 1, 9-28.

Bull, I., & Willard, G. E. (1993). Towards a Theory of Entrepreneurship. *Journal of Business Venturing*, Vol. 8, 183-195.

Camerer, C., & Weber, M. (1992). Recent Developments in Modeling Preferences: Uncertainty and Ambiguity. *Journal of Risk and Uncertainty*, 5, 325-370.

Cameron, Kim S. (1997). Techniques for making organizations effective: some popular approaches. In Druckman, D., Singer, J. E., & Van Cott, H. (Eds.) *Enhancing Organizational Performance,* Washington, D.C.: National Academy Press. Chapter 2.

Cameron, K. S., & Quinn, R. E. (2011). *Diagnosing and Changing Organizational Culture: Based on the Competing Values Framework.* San Francisco: John Wiley & Sons, Inc., 3rd edition.

Campbell, Scott (2006). Risk and the Subjectivity of Preference. *Journal of Risk Research*, Vol. 9, No. 3, 225-242.

Carroll, T., & Burton, R. M. (2000). Organizations and Complexity: Searching for the Edge of Chaos. *Computational & Mathematical Organization Theory*, Vol. 6, Iss. 4, 319-337.

Casti, John L. (1994). *Complexification: Explaining a Paradoxical World Through the Science of Surprise.* New York: HarperCollins Publishers.

Chalmers, A. F. (1999). *What is this thing called science? (3rd edition)*. Indianapolis: Hackett Publishing Company, Inc.

Chandler, G. N., DeTienne, D. R., McKelvie, A., & Mumford, T. V. (2011) Causation and effectuation processes: A validation study. *Journal of Business Venturing*, Vol. 26, Iss. 3, 375-390.

Christensen, Karina Skovvang (2005). Enabling intrapreneurship: the case of a knowledge-intensive industrial company. *European Journal of Innovation Management*, Vol. 18, Iss. 3, 305-302.

Chua Chow, C., & Sarin, R. K. (2002). Known, Unknown, and Unknowable Uncertainties. *Theory and Decision*, Vol. 52, Iss. 2, 127-138.

Collins, J. C., & Porras, J. I. (1994). *Built to Last: Successful Habits of Visionary Companies*. New York: HarperBusiness.

Collins, Jim (2001). *Good to Great: Why Some Companies Make the Leap… and Others Don't.* New York: HarperCollins.

Cooke-Davies, T., Cicmil, S., Crawford, L., & Richardson, K. (2007). We're Not In Kansas Anymore, Toto: Mapping the Strange Landscape of Complexity Theory, and Its Relationship to Project Management. *Project Management Journal*, Vol. 38, No. 2, 50-61.

Cooper, Robert G. (1990). Stage-gate systems: A new tool for managing new products. *Business Horizons*, May-June 1990, 44-54.

Cooper, R. G., Edgett, S. J., & Kleinschmidt, E. J. (2002). Optimizing the Stage-Gate Process: What Best-Practice Companies Do-II. *Research Technology Management*, Vol. 45, No. 6, 43-49.

Coughlan, P., & Coghlan, D. (2002). Action research for operations management. *International Journal of Operations & Production Management*, Vol. 22, No. 2, 220-240.

da Costa, A. F., Brettel, M. (2011). Employee Effectuation - What Makes Corporate Employees Act Like Entrepreneurs. *Frontiers of Entrepreneurship Research*, Vol. 31, Iss. 17, Article 2.

Darke, P., Shanks, G., & Broadbent, M. (1998). Successfully completing case study research: combining rigour, relevance, and pragmatism. *Information Systems Journal*, Vol. 8, Iss. 4, 273-289.

Davenport, Thomas H. (2009). How to Design Smart Business Experiments. *Harvard Business Review*, February 2009, 68-76.

Dew, N., Sarasvathy, S., Read, S., & Wiltbank, R. (2009). Affordable loss: behavioral economic aspects of the plunge decision. *Strategic Entrepreneurship Journal*, Vol. 3, Iss. 2, 105-126.

Downes, L., & Nunes, P. F. (2013). Big-Bang Disruption. *Harvard Business Review*, March 2013, 44-56.

Eisenhardt, K. M., & Brown, S. L. (1998). Competing on the Edge: Strategy as Structured Chaos. *Long Range Planning*, Vol. 31, No. 5, 786-789.

Eisenhardt, K. M., & Tabrizi, B. N. (1995). Accelerating Adaptive Processes: Product Innovation in the Global Computer Industry. *Administrative Science Quarterly*, Vol. 40, No. 1, 84-110.

Fiet, James O. (1996). The Informational Basis of Entrepreneurial Discovery. *Small Business Economics*, Vol. 8, Iss. 6, 419-430.

Fishburn, Peter C. (1989). Retrospective on the Utility Theory of von Neumann and Morgenstem. *Journal of Risk and Uncertainty*, Vol. 2, Iss. 2, 127-157.

Flyvbjerg, B., & Budzier, A. (2011). Why Your IT Project May Be Riskier Than You Think. *Harvard Business Review*, September 2011, 23-25.

Gell-Mann, Murray (1994). Complex Adaptive Systems. In Cowan, G., Pines, D., & Meltzer, D. (Eds.) *Complexity: Metaphors, Models, and Reality*, Addison-Wesley. 17-29.

Gifford, Sharon (2010). Risk and Uncertainty. In Acs, Z. J., & Audretsch, D. B. (Eds.) *Handbook of Entrepreneurship Research (2nd Ed.)*, New York: Springer Science +Business Media. Chapter 12.

Hamel, Gary (1996). Strategy as Revolution. *Harvard Business Review*, July-August 1996, 69-82.

Hassi, E., L., M.; Tuulenmäki, A., J. (2012) Experimentation-driven approach to innovation: developing novel offerings through experiments. *Proceedings of the XXIII ISPIM-conference*. Barcelona, Spain 17-20 June 2012.

Herr, K., & Anderson G. L. (2005). *The Action Research Dissertation*. London: Sage Publications.

Hmieleski, K. M., & Carr, J. C. (2008). The relationship between entrepreneur psychological capital and new venture performance. *Frontiers of Entrepreneurship Research*, Vol. 28, Iss. 4, Article 1

Hsieh, Tony (2010). *Delivering Happiness: A Path to Profits, Passion, and Purpose.* New York: Business Plus.

Hülsheger, U. R., Anderson, N., & Salgado, J. F. (2009). Team-Level Predictors of Innovation at Work: A Comprehensive Meta-Analysis Spanning Three Decades of Research. *Journal of Applied Psychology*, Vol. 94, No. 5, 1128-1145.

Iansiti, M., & MacCormack, A. (1997). Developing Products on Internet Time. *Harvard Business Review*, September-October 1997, 108-117.

Kahneman, Daniel (2011). *Thinking, Fast and Slow*. London: Penguin Books.

Kahneman, D., & Lovallo, D. (1993). Timid Choices and Bold Forecasts: A Cognitive Perspective on Risk Taking. *Management Science*, Vol. 39, No. 1, 17-31.

Kahneman, D., & Tversky, A. (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica*, Vol. 47, No. 2, 263-292.

Kanter, Rosabeth (1985). Supporting Innovation and Venture Development in Established Companies. *Journal of Business Venturing*, Vol 1, p. 47-60.

Kesting, P., & Ulhøi, J. P. (2010). Employee-driven innovation: extending the license to foster innovation. *Management Decision*, Vol. 48, No. 1, 65-84.

Kiechel, Walter III (2012). The Management Century. *Harvard Business Review*, November 2012, 63-75.

Kline S. J., & Rosenberg N. (1986). An Overview of Innovation. In Landau, R., & Rosenberg, N. (Eds.) *The Positive Sum Strategy: Harnessing Technology for Economic Growth*, Washington: National Academy Press, 275-305.

Knight, Frank H. (1921). *Risk, Uncertainty and Profit.* Boston: Houghton Mifflin.

Krueger, N. F., & Brazeal, D. V. (1994). Entrepreneurial Potential and Potential Entrepreneurs. *Entrepreneurship Theory & Practice*, Vol. 18, Iss. 3, 91-104.

Lane, D. A., & Maxfield, R. R. (2005). Ontological uncertainty and innovation. *Journal of Evolutionary Economics*, 15, 3-50.

Langlois, R. N., & Cosgel, M. N. (1993). Frank Knight on risk, uncertainty, and the firm: A new interpretation. *Economic Inquiry*, Vol. 31, July 1993, 456-465.

Lee, F., Edmondson, A. C., Thomke, S., & Worline, M. (2004). The Mixed Effects of Inconsistency on Experimentation in Organizations. *Organization Science*. Vol. 15, No. 3, 310-326.

Lehrer, Jonah (2009). *How We Decide.* New York: Houghton Mifflin Harcourt Publishing.

Lenfle, S., & Loch, C. (2010). Lost Roots: How Project Management Came to Emphasize Control Over Flexibility and Novelty. *California Management Review*, Vol. 53, No. 1.

Loch, C. H., DeMeyer, A., & Pich, M. T. (2006). *Managing the Unknown: A New Approach to Managing High Uncertainty and Risk in Projects*. Hoboken, New Jersey: John Wiley & Sons, Inc.

Loch, C. H., Solt, M. E., & Bailey, E. M. (2008). Diagnosing Unforeseeable Uncertainty in a New Venture. *Journal of Product Innovation Management*, Vol. 25, Iss. 1, 28-46.

Loewenstein, George (2001). The Creative Destruction of Decision Research. *Journal of Consumer Research*, Vol. 28, No. 3, 499-505.

Loewenstein, G. F., Weber, E. U., Hsee., C. K., & Welch, N. (2001). Risk as Feelings. *Psychological Bulletin*, Vol. 127, No. 2, 267-286.

March, James G. (1991). Exploration and Exploitation in Organizational Learning. *Organization Science*, Vol. 2, No. 1, 71-87.

Matta, N. F., & Ashkenas, R. N. (2003). Why Good Projects Fail Anyway. *Harvard Business Review*, September 2003, 109-114.

McGrayne, Sharon Bertsch (2011). *The theory that would not die: How Bayes' rule cracked the Enigma Code, hunted down Russian submarines, and emerged triumphant from two centuries of controversy*. Yale University Press.

Menzel, H., Krauss, R., Ulijn, J., & Weggeman, M. (2008). Developing characteristics of an intrapreneurship-supportive culture. In Fayolle, A. & Kyrö, P. (Eds.) *The Dynamics between Entrepreneurship, Environment and Education*, Cheltenham (UK): Edward Elgar Publishing, Ch. 5, 77-102.

McGrath, Rita Gunther (1999). Falling Forward: Real Options Reasoning and Entrepreneurial Failure. *The Academy of Management Review*, Vol. 24, No. 1, 13-30.

McGrath, Rita Gunther (2010). Business Models: A Discovery Driven Approach. *Long Range Planning*, Vol. 43, 247-261.

McKay, J., & Marshall, P. (2001). The dual imperatives of action research. *Information Technology & People*, Vol. 14, No. 1, 46-59.

McMullen, J. S., & Shepherd, D. A. (2006). Entrepreneurial action and the role of uncertainty in the theory of the entrepreneur. *Academy of Management Review*, Vol. 31, No. 1, 132-152.

Menashe, D., & Shamash, M. E. (2005). The Narrative Fallacy. *International Commentary on Evidence*, Vol. 3, Iss. 1.

Miller, Kent D. (2007). Risk and Rationality in Entrepreneurial Processes. *Strategic Entrepreneurship Journal*, Vol 1, 57-74.

Monsen, E., Patzelt, H., & Saxton, T. (2010). Beyond Simple Utility: Incentive Design and Trade-Offs for Corporate Employee-Entrepreneurs. *Entrepreneurship Theory and Practice*, January 2010, 105-130.

Morgan, G., & Smircich, L. (1980). The Case for Qualitative Research. *Academy of Management Review*, Vol. 5, No. 4, 491-500.

Oberkampf, W. L., Helton, J. C., Joslyn, C. A., Wojtkiewicz, S. F., & Ferson, S. (2004). Challenge problems: uncertainty in system response given uncertain parameters. *Reliability Engineering and System Safety*, Vol. 85, Iss. 1-3, 11-19.

Peters, T. J., & Waterman, R. H. (1982). *In Search of Excellence: Lessons from America's Best-Run Companies*. New York: Harper & Row.

Pich, M. T., Loch, C. H., & De Meyer, A. (2002). On Uncertainty, Ambiguity, and Complexity in Project Management. *Management Science*, Vol. 48, No. 8, 1008-1023.

Read, S., Song, M., & Smit, W. (2009). A meta-analytic review of effectuation and venture performance. *Journal of Business Venturing*, 24, 573-587.

Rutherford, M. W., & Holt, D. T. (2007). Corporate entrepreneurship: An empirical look at the innovativeness dimension and its antecedents. *Journal of Organizational Change Management*, Vol. 20, No. 3, 429-446.

Sarasvathy, Saras D. (2001). Causation and Effectuation: Toward a Theoretical Shift from Economic Inevitability to Entrepreneurial Contingency. *The Academy of Management Review*, Vol. 26, No. 2, 243-263.

Sarasvathy, Saras D. (2008). *Effectuation: elements of entrepreneurial expertise*. Cheltenham (UK): Edward Elgar Publishing.

Sarasvathy, S. D., & Dew, N. (2005). Entrepreneurial logics for a technology of foolishness. *Scandinavian Journal of Management*, 21, 385-406.

Sarasvathy, S. D., Dew, N., Read, S., & Wiltbank, R. (2008). Designing Organizations that Design Environments: Lessons from Entrepreneurial Expertise. *Organization Studies*, 29(03), 331-350.

Schrader, S., Riggs, W. M., & Smith, R. P. (1993). Choice over uncertainty and ambiguity in technical problem solving. *Journal of Engineering and Technology Management*, Vol. 10, Iss. 1-2, 73-99.

Senge, Peter M. (2006). *The Fifth Discipline (Revised Edition)*, London: Random House.

Seidel, Victor P. (2007). Concept Shifting and the Radical Product Development Process. *The Journal of Product Innovation Management*, Vol. 24, Iss. 6, 522-533

Silver, Nate (2012). *The Signal and the Noise: Why So Many Predictions Fail - but Some Don't.* New York: The Penguin Press.

Simon, Herbert Alexander (1996). *The Sciences of the Aritificial.* Cambridge: The MIT Press, 3rd edition.

Slovic, Paul (1987). Perception of risk. *Science*, Vol. 236, No. 4799, 280-285.

Slovic, Paul (1998). The Risk Game. *Reliability Engineering and System Safety*, Vol. 59, Iss. 1, 73-77.

Slovic, P., Finucane, M. L., Peters, E., & MacGregor D. G. (2004). Risk as Analysis and Risk as Feelings: Some Thoughts about Affect, Reason, Risk, and Rationality. *Risk Analysis*, Vol. 24, No. 2, 311-322.

Sommer, S. C., & Loch, C. H. (2004). Selectionism and Learning in Projects with Complexity and Unforeseeable Uncertainty. *Management Science*, Vol. 50, No. 10, 1334-1347.

Sunstein, Cass R. (2007). Moral Heuristics and Risk. In Lewens, Tim (Ed.) *Risk: Philosophical Perspectives.* New York: Routledge. Chapter 9.

Sykes, H. B., & Dunham, D. (1995). Critical assumption planning: A practical tool for managing business development risk. *Journal of Business Venturing*, 10, 413-424.

Taleb, Nassim Nicholas (2007). *The Black Swan: The Impact of the Highly Improbable*. New York: Random House.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic Capabilities and Strategic Management. *Strategic Management Journal*, Vol. 18, Iss. 7, 509-533.

Thomke, Stefan H. (1998). Managing Experimentation in the Design of New Products. *Management Science*, Vol. 44, No. 6, 743-762.

Thornberry, Neal E. (2002). Corporate entrepreneurship: teaching managers to be entrepreneurs. *Journal of Management Development*, Vol. 22, No. 4, 329-344.

Tuulenmäki, A., & Välikangas, L. (2011). The art of rapid, hands-on execution innovation. *Strategy & Leadership*, Vol. 39, No. 2, 28-35.

Vandenbosch, M., & Clift, T. (2002). Dramatically reducing cycle times through flash development. *Long Range Planning*, 35, 567-589.

Wheatley, Margaret J. (2006). *Leadership and the New Science: Discovering Order in a Chaotic World.* San Francisco: Berret-Koehler Publishers, 3rd edition.

Williams, T. M. (1999). The need for new paradigms for complex projects. *International Journal of Project Management*, Vol. 17, No. 5, 269-273.

Wiltbank, R., Dew, N., Read, S., & Sarasvathy, S. D. (2006). What to do next? The case for non-predictive strategy. *Strategic Management Journal*, 27, 981-998.

Xu, H., & Ruef, M. (2004). The myth of the risk-tolerant entrepreneur. *Strategic Organization*, Vol. 2(4), 331-355.

Zuber-Skerritt, O., & Perry, C. (2002). Action research within organisations and university thesis writing. *The Learning Organization*, Vol. 9, No. 4, 171-179.

Åmo, Bjørn Willy (2005). *Employee Innovation Behavior*. Ph. D. Bodø Regional University.

Appendices

Appendix 1: Experimentation Sprint Interview Structure[6]

Background information of the interviewee

- Job in the organisation, how long has the interviewee been in the current job?

Sprint experience

- Can you tell what you did during the Sprint?
  - What was the idea you were developing?
  - How did developing the idea proceed? What did you do?
  - Who were developing the idea? Who participated in the development process?
- *[Show the Roller Coaster sheet of the interviewee]*[7] Can you describe how the sprint was for yourself? (Examine the Roller Coaster sheet)
  - What was easy? (What made it easy?)
  - What was difficult? (What made it difficult?)
  - Did something surprising / unexpected happen?
    - How did you act on the situation? *[The idea is to find out how they managed when things did not go according to expectations]*
  - What were your personal turning points *[critical incidents]* during the sprint — for example, what events caused you to experience strong excitement or discouragement
- Where do you think you succeeded? (Why?)
  - What caused an experiment to be successful / How do you know that it was successful?
  - Which factors could have contributed to its success? What was the situation?

[6] Translated by me from Finnish to English.

[7] The Project Emotional Roller Coaster is a prototype tool created by the MIND research group for visual tracking of what kinds of emotions — such as excitement, frustration, despair, triumph, vulnerability, anxiety, confidence etc. — people experience during different phases of a development project.

- Where do you think you failed? (Why?)
    - What caused an experiment to be a failure / On what basis was it a failure?
    - What contributed to the failure?
- How was the atmosphere in your team during the Sprint?
    - What contributed to the atmosphere?
    - Did everyone participate equally?
    - Did everyone talk openly about their ideas?
    - Were there disagreements? How did they affect the atmosphere?
- What support did you get from your organisation / team in executing the experiments?
    - What support did you miss?
- What kinds of roles were there in your team?
    - Was someone clearly an initiator / decision-maker / coordinator? Give an example.
    - Was there a dominant person / did someone hold tight to their opinions and ideas?
    - How was your own role? / Did the way someone else acted / behaved affect it?

Example

"Let's take one of your ideas that you did not experiment on."

Ideas of the Pit Stop group (based on the ENUF list)[8]

- Let's not give ready-made answers, tasks. More responsibility to lower levels of hierarchy (all decisions under 1000 € without supervisor's approval)
- A circulating Monday breakfast in the business unit is a nice way to start the week
- Anonymous box for suggesting ideas

[8] ENUF stands for Exciting, New, Useful, Feasible. It is a tool used in the Experimentation Sprint to evaluate and rank ideas based on different attributes.

Ideas of the Decision Cards group (based on the ENUF list)

- "Friday fun" for example candy, pastries, 30 minute activities
- ML living room where you could at least make coffee, fruits being served
- Bring the history of the organisation as part of meeting room decor
- Internal competition about different kinds of meeting rooms outside the organisation + collecting them in intranet (for inspiration)
- More straightforward approval processes - for example, < 1000 euro purchases => everyone can do themselves

- How would you now proceed with developing this idea?
- What would you differently this time, compared to your first experiment?

Closing…/ Current situation in Mandatum

- How did the sprint differ from your normal approach to developing ideas?
  - Has experimentation been used earlier for developing ideas?
- What will happen next to your idea?
- What did this experience give you? How are your feelings towards the Sprint?
  - Which particular things gave positive feelings?
  - Which particular things gave negative feelings, or otherwise created anxiety?